"Many a famous scientist of to-day learned his first lessons while gathering, indentifying and labeling his boyhood collections"

THE BOY COLLECTOR'S HANDBOOK

BY

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ILLUSTRATED WITH MANY PHOTOGRAPHS AND DIAGRAMS

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PART I

NATURAL OBJECTS

THE BOY COLLECTOR'S HANDBOOK

CHAPTER I

WHY AND WHAT TO COLLECT

THERE are many reasons why boys should collect something. In the first place collecting furnishes an interest, an ambition, and a definite object; and, moreover, a boy can scarcely collect anything without adding to his education and knowledge. To collect some things it is necessary to get out in the open, to stroll through fields and forests, and this in itself makes collecting worth while. Finally, collections, if properly made, cared for, and classified, are often of great intrinsic value, and many a youthful collection has been sold for a large sum after the young collector had grown to manhood.

As to just what to collect, each boy must decide for himself. As a general rule, collect the things

in which you are most deeply interested. If you are fond of outdoor life and take an interest in flowers, plants, insects, minerals, or other natural objects, by all means select one or two of these for your collections. If, on the other hand, you are fond of history, geography, travel, strange people, or similar subjects, you should collect objects relating to them, such as antiques, weapons, war relics, documents, native handiwork, stamps, coins, etc.

But don't try to collect too much; it's almost impossible to collect a great variety of objects of widely different kinds and do justice to them all. Another matter which should influence the choice of objects to collect is that of expense. It costs a great deal to collect some things and few boys can afford to spend the necessary money. Good antiques, old books, armor, valuable autographs, and even coins all have a high market value and are better suited to wealthy, advanced collectors or great museums than to boys. Such things must usually be purchased or exchanged and, moreover, there are so many counterfeits and forgeries constantly offered that an expert knowledge and long experience is required to tell the real from the spurious articles.

There are numerous other things which may be

collected at far less expense and which are just as interesting, however. Stamps, exclusive of the rarest issues, are fairly cheap if purchased, and, as a rule, the young collector may obtain a very complete and interesting collection of stamps without buying a single specimen.

Many interesting war and historical objects may be obtained with little cash outlay, but in every case, where man-made objects are collected, you must either buy, beg, or exchange the specimens. For this reason collections of natural objects are far more satisfactory, for the collector can secure and prepare the specimens himself and in doing this will learn far more of interest and value than would be possible when merely purchasing or trading the specimens from others. A great many people boast of the cost of their collections; apparently thinking that the more expensive a collection is the more valuable it becomes. On the other hand, many collectors are proud of the size of their collections and state that they contain so many thousand stamps, plants, or what not, evidently believing that mere numbers of specimens prove the value of their possessions. As a matter of fact, neither cost nor quantity necessarily means that the collection is

really valuable. A certain stamp, coin, or other specimen may cost thousands of dollars and yet that one object would not constitute a collection and might not be one-tenth as interesting or valuable as would a well-selected, typical series of specimens costing a few cents, or nothing at all. It is the same way with size. A collection may number thousands of specimens and yet be so badly arranged, so improperly classified, so poorly preserved or otherwise so lacking in interest or value as a whole to be worthless. Any one can gather together a half million or more common postage stamps or wild flowers, but that wouldn't prove that the accumulation was a good collection.

The objects to aim at in collecting anything and everything are first; completeness. Second; interest. Third; perfection. Fourth; classification. Fifth; arrangement; and last; attractiveness. Instead of dividing your efforts and striving to collect half a dozen different things at once, confine your collections to one certain line until that line is as complete as possible. Of course this does not mean that you should pass by and lose a specimen of one thing simply because you're looking for another—rare opportunities often come to the collector by

chance; but keep your mind centered on the particular object in view and let others be side issues. There are few who can make a successful collection of a number of widely different objects, and it takes years of practice and a natural "collector's instinct" to accomplish it. The author was for many years a professional natural history collector. On my various trips and expeditions I invariably made one certain line of specimens my chief object and while "all was fish that came to my net," yet I found that I could accomplish far more in this way—and by keeping eyes and ears open—than by having no particular object in view and looking aimlessly for anything and everything. I have secured many a rare insect while hunting birds, many a valuable plant while seeking insects or reptiles; but in every case these were merely bits of luck and the result of eyes trained to note any unusual thing.

The collector who starts forth searching for minerals will have better success in collecting minerals than the fellow who goes out to collect anything that comes along, and the same is true with every other class of specimens. Don't be discouraged if the first few objects you obtain are poor or injured—don't discard them; but wait until you get better

specimens to replace them. An imperfect or small specimen is far better than none at all and may serve to fill a gap in a series for a long time. Don't let a specimen pass merely because it's common; when collecting there is no time like the present—in a few months or even weeks the common thing may become rare and, even if it does not, the sooner you collect it and have done with it the better. After it is added to your collection it won't bother you any more and you can dismiss it from your thoughts once and for all.

Don't forget that the things common and uninteresting in your locality may be very rare in others and that such things may be traded to advantage, so always have duplicates on hand if possible. Even if you don't trade them, duplicates may come in handy at any time if you break, lose, or injure a specimen. Try to make your collections just as complete as possible; if you collect stamps, endeavor to fill out sets of each country rather than to have a few of one and a few of another country; and if you collect plants, insects, or minerals, try and obtain a complete series of the species or varieties found in your neighborhood before giving much time to those from other districts. By "interest" I

mean natural, human interest, educational interest, and popular interest combined. A specimen may be interesting as a curio and yet have no educational interest whatever, or it may have an educational interest and value and yet not interest one person in ten thousand who sees it. Many war relics and other things have a human interest from associations, and yet to one who does not know their history they may seem mere rags or "junk." So also certain things have a popular interest and will attract every one who sees them, and yet, from an educational or scientific viewpoint, they may be worthless. Strive to combine these various interests in your collections and make your collections serve as many useful purposes as possible. Lots of things possess a great deal of real human interest once we learn something of them, and it is in thus bringing out the real interest in objects that the collector benefits mankind and that the collection becomes educational.

Of course every one should try to have his specimens as perfect as possible; but even if each object is faultless in this respect the collection may be so badly arranged, so incorrectly labeled or classified, or so unattractively displayed as to be imperfect as

a whole. Merely gathering or collecting the specimens is not the main thing; it's just as important to have the specimens properly and correctly labeled, neatly arranged, and well cared for as to get them in the first place. A mass of material thrown hodge-podge into a chest or drawers, and without labels or other data, is of mighty little value or interest. If a thing's worth collecting at all it's worth looking after, labeling, and classifying. It isn't necessary to be an expert in any line in order to classify and label your specimens—you can learn more about them by doing this than in any other way, and many a famous scientist of to-day learned his first lessons while gathering, identifying and labeling his boyhood collections.

There are many ways of identifying and classifying your collections. In the first place there are books treating of nearly every object that can be collected, and by referring to these you can usually identify your specimens and can learn much of value and interest in regard to them. Public museums are also very useful, and oftentimes you can more easily identify a specimen by comparing it with the museum collections than by reference to printed descriptions and illustrations. If, as sometimes

happens, you are unable to identify a specimen through either or both of these methods, the specimen itself or a duplicate—or even a sketch or photograph—may be sent to some well-known authority with a request for information. Nine times out of ten your request will be granted courteously and willingly, for there is a strong bond of sympathy and fellow-feeling between all collectors.

Have every specimen labeled and catalogued. In the case of stamps, autographs, and many other objects which are usually kept in books or portfolios, this is very simple, and, in fact, the position of a stamp or postcard in a book is in itself equivalent to a label.

Objects kept in drawers, cases, cabinets, jars, or any other situations should be very carefully labeled, however. It's an easy matter for a specimen to be misplaced and while you may remember it and know just what it is, where it came from, and all about its history, yet others will not, and a really rare specimen may for this reason become utterly worthless.

Whenever possible a specimen should bear a descriptive label, with the name (both English and scientific), date of collection (in the case of an-

tiques, the date of its manufacture or use), how it was obtained, locality, sex (in the case of animate objects), and any interesting facts regarding its history, habits, etc. In addition to this label, the specimen should be numbered, either in ink or paint, and a similar number should be entered in a catalogue, followed by a full description of the specimen, with its name. This is very important, for if the large label is misplaced, lost, or detached, a reference to the catalogue will serve to set all doubts at rest.

In the case of very small or delicate objects it is often impossible, or at least difficult, to provide them with individual labels, and in such cases the number and catalogue description alone must be depended upon, although a label may, if desired, be placed in the box, tray, or drawer with the specimen.

Labeling and cataloguing may seem very small and unimportant matters, and beginners and amateurs often overlook their importance. This is a great mistake, for the value or interest of a collection depends to great extent upon the accuracy and care with which it is labeled and catalogued.

Arrangement is another important matter. Just

what method you follow will depend a great deal upon the character of the collection, the object you have in view, and the number of specimens, as well as your own resources and good judgment. If you wish to exhibit your collections they should be arranged with this idea, whereas, if you collect for your own satisfaction and only show the specimens to a few favored friends, a very different arrangement may be followed. A great deal also depends upon the character of the specimens themselves. Some things, as for example rocks, fossils, shells, etc., require little care or protection and may be arranged in boxes, trays, cabinets, cases, drawers, or shelves, for there is little danger of their being injured by light, exposure, air, or dust. On the other hand, delicate specimens, such as butterflies, plants, flowers, etc., must be carefully protected from the dust, sun, and air, as well as from insect pests. Collections of antiques or relics, which include articles of hair, cloth, feathers, or other fabrics, must be carefully protected, for the moths and other insects, bright light, dry air, and dust are all to be guarded against.

If you have duplicates of any or all of your specimens you should invariably keep one set for display

or exhibition and another for reserve, and then if anything happens to the exhibition specimen you will have the one held in reserve to take its place.

When arranging specimens for exhibition, try to follow out some definite system. If your collection consists of historical relics, arrange them as nearly as possible in the order of their age. If the collection is intended to show the development or evolution of a certain class of objects, arrange the specimens to show this. If the collection is of natural objects, such as plants, insects, marine life, minerals, etc., arrange the specimens in groups illustrating the various families, genera, species, etc., or else in groups to show the varieties or species found in certain localities.

Many interesting collections can be made of very simple, everyday things arranged and classified in such a way as to illustrate the various steps and processes of manufacture or preparation. Aside from the enhanced value which arrangement gives to a collection, is the question of attractiveness. This may seem of little importance and if you expect to keep your collections strictly private and never exhibit them, attractiveness is of no particular consequence. It is seldom indeed that a collector does

this, however, and half the fun in collecting is in showing your collections to visitors and friends. A collection may seem very interesting and attractive to the owner and yet may fail to interest or attract others, merely because it is not attractively displayed or arranged. A dirty, dusty lot of specimens is never attractive nor interesting, no matter how valuable or rare the specimens may be. A collection of simple, common things, neatly labeled, well arranged, properly cared for, and displayed in orderly trays, drawers, or cabinets, is far more attractive and interesting than a disorderly, poorly labeled and carelessly arranged collection of rare or valuable things.

Before you can commence identifying, labeling, or arranging your collections you must decide what to collect, and this is perhaps the most difficult task of all. In a broad way, everything may be divided into two great classes: man-made objects and natural objects. In the former are war and historical relics, antiques, Indian relics, coins, stamps, books, art objects, autographs, and many similar things. In the other class are woods, leaves, flowers, fruits, rocks and minerals, fossils, marine specimens, insects, birds, birds' eggs, etc. Many of the

latter class of objects grade into the former, for a complete collection includes not only the true natural objects but the various articles or preparations made from them by man. Thus, in a mineral collection, articles made from the raw materials should be shown in order to illustrate their economic or industrial value and uses, and this is true also of plants, marine animals, and many other things. In the same way a collection of man-made objects is far more valuable and interesting if it includes specimens of the raw materials from which the specimens are made.

Certain objects in both of these great classes should be eliminated by the young collector, for various reasons. Thus, among the man-made objects, true antiques—such as furniture, armor, etc; objects of arts, such as paintings, statuary, carvings, etc.; rare books and even autographs—should be avoided owing to their bulk, cost, or the danger of spurious imitations. So also, among natural objects, you should refrain from collecting birds, birds' eggs, and most animals. These are all very well for the larger museums and for advanced scientific collectors, professional ornithologists, and naturalists, for only by actually collecting the birds and

their eggs and the animals can scientists teach us their value, habits, and many other matters. The young collector, however, seldom gives the world any additional knowledge of value and merely destroys life for the sake of gathering together a collection for his own amusement or benefit. It cannot be denied that collections of birds and birds' eggs are interesting and attractive; but with modern photography, collections of photographs of live birds and animals and birds' nests can be made, and these will serve every purpose of a collection of the real specimens. Moreover, far greater skill and knowledge is required to make a complete collection of bird photographs than to make a collection of the birds themselves, and such a collection is far less trouble, more lasting, and more easily arranged and exhibited than a collection of real birds or birds' eggs.

While we cannot afford to sacrifice the lives of any birds, yet with insects and marine life the case is entirely different. The great majority of our insects are injurious, and by collecting them we are really doing an excellent work and are benefiting our gardeners and agriculturists. Properly collected insects do not suffer, and to catch a butter-

fly, kill it instantly with benzine, and preserve it is far more humane than to crush the caterpillar, which devours our plants, underfoot. Sentimentalists may think with regret of killing butterflies, but they shudder with aversion at a big green "worm" and do not hesitate to step upon an injurious larva or to spray their plants with slow poisons, and yet the same ugly worm is only the butterfly in another form.

Neither is there any valid reason for not collecting marine animals. It is not half so cruel to preserve some low form of marine life in alcohol or formaldehyde as to open a live oyster and eat it or to drop a living lobster or crab in boiling water. Moreover, the marine animals are really less known to the average person than any other class of animal life and a great deal of real educational value may be learned by collecting them.

If for any reason you or your parents object to collecting such things as insects or marine animals, there are still plenty of other natural objects to collect. Plants are found everywhere, and good collections of plants, flowers, seeds, fruits, etc., are always interesting, instructive, and valuable. Rocks and minerals offer a splendid field, fossils are

marvelous and fascinating, and last, but by no means least, is the wonderful world opened to us through the use of the microscope. A collection of microscopic objects is a never-ending source of interest, value, and education, and the boy with a microscope and a collection of slides can dwell for hours and days in a veritable fairyland of his own.

CHAPTER II

ROCKS AND MINERALS

OF all natural objects probably the easiest and simplest to collect are rocks and minerals. There is scarcely an inhabited country in the world where rocks or minerals of some kind do not exist. Even on plains or prairies where rocks—as we commonly know them—are not found, there are sand, earth, clay, or similar things which are really included in the mineral class, and practically the only spots where some form of mineral is not found are swamp lands. By this I do not mean that a boy living on a plain or prairie can obtain a good collection of either rocks or minerals, and boys living where real rocks and minerals are scarce should select some other class of specimens for their collections.

In most places, however, rocks and minerals are quite common and the average boy will find little difficulty in making a large and interesting collec-

tion of minerals from his own neighborhood. The variety of rocks and minerals which may be found in one small locality is really remarkable, and until you commence to hunt for specimens you cannot realize how many there are. A single ledge or cliff of rock may, upon close inspection, reveal a score or more of minerals, while the bed of a brook or river may yield a hundred or more varieties of rock among the water-worn pebbles.

It is not only simple and easy to collect minerals, but the tools and implements required are few and inexpensive, the specimens are easy to prepare and preserve, they are not injured by dust, sunlight or insects, and in most cases they are readily identified and classified.

Many rocks and minerals are intrinsically valuable and a great many more are of great value as specimens. Minerals which are excessively rare in most places may be very abundant locally, and if the young collector finds such deposits he can readily sell or exchange specimens to great advantage.

The tools and implements required for collecting rocks and minerals are as follows: A good geologist's hammer, a cold chisel, a stone drill, some stone wedges, a stout canvas or leather bag.

If you cannot obtain a geologist's hammer, an ordinary blacksmith's or machinist's hammer will answer. One cold chisel will serve your purpose, but several of various sizes are preferable. The drill may be omitted in most cases, as this tool, as well as the wedges, are only useful in splitting large pieces of rock or ledges or in blasting. A pick-ax is often useful or even essential, as is a small spade, for in many localities it is necessary to dig away loose rock and earth to reach the ledges, veins, or solid rock beneath. These need not be taken on every collecting trip, however, for if you find a spot where they are required you can make a special trip fully equipped to carry on your amateur mining operations.

As in every class of collecting, two boys can work to better advantage than one when collecting minerals. In the first place it's more enjoyable to have a companion along; there's less liability of being injured or disabled by slipping or falling, and with two boys there's just twice as many chances of finding rare things. Moreover, when two are along it makes collecting a game and each will do his best to find more and better specimens than the other. Then at the end of the trip you can compare notes

and can trade specimens, provided you do not both obtain the same sort of specimens. In selecting a companion for your collecting trip do not choose a boy who is jealous, cranky, surly, obstinate, or overbearing—such boys spoil the trip and are a nuisance. It's far better to go alone than to have a disagreeable companion or one who is always complaining, getting tired, or losing interest. When collecting minerals—or for that matter anything in the woods, fields, or along the seashore—wear old, strong clothes and stout, easy boots. You'll feel much more comfortable if you don't have to look after your clothes, and knocking about among rocks, brambles, or mud flats is hard on clothing.

The best places in which to search for mineral specimens are ledges, cliffs, and mountain sides. Quarries—especially old ones—are fine fields for the mineral collector, and the rough granite ledges which jut from the earth on hillsides and hilltops are often veritable treasure troves. The pebbly, rocky beds of brooks and rivers are also fine collecting grounds, for here the rocks from far and near are washed clean and exposed. At first glance these may all seem much alike, but if you crack a few of the water-worn cobbles open you'll be surprised to

find how many different kinds there are. Even rocks which are not found at all in the ledges and cliffs of the vicinity may occur in the beds of streams, for they are often carried immense distances by the ice in spring and in many districts the ancient glaciers brought masses of rock and loose stones from regions hundreds of miles distant and dropped them here and there upon the earth.

A great deal of the fascination in collecting any natural object is that one never knows what one may find. This is particularly true of rocks and minerals. A dull, rounded stone may, when broken open, reveal a magnificent crystal-filled hollow. Such formations are known as GEODES and in some localities they are very abundant. At other times a few glittering crystals or an insignificant bit of metal in a rock or ledge may lead you to wonderful discoveries. Many uninteresting granite ledges hide marvelous stores of magnificent crystals. The rich tourmaline mines of Maine were discovered by a farmer's boy in search of minerals, and beryls, aquamarines, garnets, topaz, and many other rare precious and semi-precious stones occur in pockets in granite and other common rocks. Sometimes the crystals are found lying loose on the surface where

they have been left exposed by the decomposition of the surrounding rock. At other times a blast will reveal the hidden treasures, and if at any time you find traces of crystals or veins of ore it is a good plan to drill a few holes and blast away a portion of the rock. In mining localities you may obtain a great number of very rare and interesting specimens. As a rule, metal ores are found associated with various other substances, and the combinations formed by the metal with other minerals and their salts produce an almost endless variety of minerals and an infinite number of colors and forms. Miners and quarrymen frequently find interesting and beautiful specimens which are thrown aside, and if you can get acquainted with these men they will be of the greatest help in securing fine specimens for you.

Moreover, you can spend many hours, or days, on a single cliff or ledge and still obtain new things, and only by going over each outcrop of rock with great care can you hope to obtain a representative collection of the minerals of your vicinity.

Good specimens do not depend upon size alone. Some of the finest specimens are small, for the perfection of shape, the color, form, and typical ap-

pearance counts more than mere size in most cases. In the case of crystals, however, it is different. The larger the crystal the better, provided the color and form are good, and you should always strive to collect crystals as perfect and as large as possible. Crystals often occur in large groups or masses, and as most crystals are as brittle as glass great care should be used in getting them out. Don't try to knock off crystals or groups of crystals with a hammer—the shock or jar alone will often break them—but cut around the crystal or the mass of crystals with a cold chisel and hammer. If the crystals are very large or slender, pack cotton, wool, bits of cloth or even hay, grass, or moss, among them while you work. This will often prevent them from being shattered by an accidental jar and will protect them until you reach home. When carrying crystals never throw them loosely among other rocks in your bag. Pack them in pieces of cloth or burlap and carry them in a separate bag or in your pockets if possible. If you collect in a locality where limestone formations occur, you may find the entrance to a cave or cavern and within this you will probably discover many beautiful stalactites and stalagmites. The former are white or tinted, conical or

tapered formations hanging from the roof of the caves, and the latter are protuberances rising from the floors. These are both formed by water containing lime in solution which percolates through the rocks. Where the water drips from above the lime crystallizes and hardens, and as the water continues to follow down on the tiny excrescence thus formed, a pendant stalactite is gradually produced. Wherever the water drips from the stalactites to the floor beneath, other cones of limestone are built up and in time many of the stalactites and stalagmites join and form columns or pillars. Both stalactites and stalagmites vary in size from tiny, needle-like things to huge cones several feet in diameter and the columns which join them also vary in the same way (Fig. 1). At times the lime-filled water runs over rocks, ledges, sand, or boulders and covers them with a thin, stony covering of transparent dripstone. This is often delicately tinted and so beautifully formed that it appears like intricate carvings or fine stone lacework. Some of the largest known caves, such as the Luray and Mammoth caves, the famous Bellamar caves of Cuba and the Crystal Cave in Bermuda, were discovered by accident. As these limestone caves may be of vast extent and

many of them are partly filled with water, great care should be taken in exploring them. A light or torch should always be carried, and if you are alone, or the cave is large, you should fasten one end of a ball of twine at the entrance and unwind it as you proceed. This will enable you to find your way back in case you become confused or lost, which may easily happen in a large cavern.

Some kinds of minerals are often found in soft earth, sand, mud, or clay and after heavy rains or washouts they may be seen lying exposed on hill-sides, on the banks of brooks, or in cut banks. Many of these are crystals which were originally embedded in solid rock, but which have been freed by the action of weather through countless centuries. Topaz crystals often occur in such situations and in many places very curious crystal-like formations of sandstone are found in similar situations (Fig. 2). Clay beds often yield strange masses of stonelike material known as CONCRETIONS (Fig. 3). They are usually recognizable by the concentric layers or rings which are visible when the masses are broken apart, and while not true minerals they are interesting and a collection illustrating their various forms is well worth making. On bare and sandy

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3

Various Crystals

(See Chapter II)

1—Interior of a Limestone Cave Showing Stalactites

(See Chapter II)

plains and prairies meteorites are often found. These are fragments of shooting stars or meteors, sometimes known as aëreolites, and are always interesting and valuable. There are two general classes of meteorites, known as stony meteorites and metallic meteorites. The former are sometimes difficult to distinguish from ordinary rocks, but the latter may be recognized by their weight, their metallic surface, and the rust which covers them when they have been long exposed to weather. Meteors are no more abundant on plains than elsewhere and the only reason that more of them are discovered in such places is because they are more readily seen. On a plain, where stones are unknown, a meteorite —even if very small—will attract attention, whereas in a stony or wooded country a very large one might pass unnoticed. All meteorites are valuable and some of them are worth more than their weight in gold, so the boy collector should always keep his eyes open for these fragments from other worlds.

After you have collected your specimens they should be carefully washed, cleansed, and labeled. If you have difficulty in identifying the specimens by descriptions and figures in books or by comparison with museum specimens, you can send them to

some mineralogist. Most mineralogists are very glad to help amateurs identify their specimens, and whenever you find an unknown or unusual specimen that you cannot classify a piece should be sent to some expert with permission to retain the specimen. Many of the things you send will be so common that they will be worthless to the mineralogist, but some may be rare or of unusually perfect form or color and such will repay the person for his time and trouble. If you wish to study minerals or rocks very deeply you will require books and technical works on mineralogy and you will also have to learn about blowpipe analysis. For the young collector, however, this is not necessary, and it is in reality a matter entirely distinct from collecting.

In arranging your mineral collections you should aim to keep each group of minerals by itself. Thus, all the various forms of iron ore may be grouped together, all the forms of quartz may be placed in another group, all the limestones in another, all the conglomerates in another, and so on. Granite, marble, or other commercial stones and rocks should be exhibited, both in the rough and finished conditions, and if it is possible to do so, gems and semi-precious stones should be shown in both the cut and

uncut state. The majority of mineral and rock specimens may be displayed in open trays, cases, or cabinets, but some varieties show to better advantage when set off by special surroundings. Thus, clear, transparent crystals look better when arranged on dark backgrounds, such as black cardboard or velvet, while dark-colored crystals look best on light colored backgrounds (Fig. 4). Cal-

Fig. 5. Calcite crystals have the peculiar property of causing all things to appear double when seen through the mineral

cite has the peculiar property of producing double refraction. That is, a line, letter, or other mark seen through a transparent piece of calcite appears double and specimens of this mineral should be exhibited with a ruled card or paper beneath them to illustrate this feature (Fig. 5).

In every case the specimens should be arranged to exhibit their peculiarities or typical forms to the

very best advantage. There is scarcely a piece of rock or a crystal which is equally good on all sides, and care should be taken to have the best side on view. Many rocks and minerals have a form of cleavage or a stratified structure which is peculiar to their kind, and when such is the case you should aim to show this. Other minerals have physical peculiarities which should be illustrated. For example, flexible sandstone, when in thin strips, will bend readily, but in short or thick pieces is scarcely distinguishable from ordinary sandstone. In such a case a thin piece should be supported between blocks to illustrate its flexible character. If a rock or mineral is composed of a number of different minerals it is an excellent plan to show, not only the rock itself, but each of its component parts. Granite should be shown with quartz, feldspar, mica, and hornblende beside it, and similar methods should be followed with other rocks composed of various minerals.

A most interesting exhibit may be made of minerals and rocks used for commercial purposes. Mica, for example, should be shown in its raw, massive state and beside it the thin flakes or sheets

should be placed, as well as ground or pulverized mica. Asbestos may be shown in its natural form and with it you should place the selected fibers, asbestos felt, asbestos paper, asbestos cloth, and similar asbestos products. Various other minerals, such as sulphur, gypsum, iron, copper, etc., may be treated in the same way.

Although the larger and more bulky specimens may be safely placed in open drawers, trays, boxes, or even on shelves, the smaller and more valuable specimens should be protected. They may be placed in glass-covered trays or boxes or in small vials with cotton, or they may be wired, tied, cemented, or otherwise formly attached to stiff cardboard or wooden mounts. Minerals should be numbered with indelible ink or paint wherever possible, and small crystals or similar specimens, attached to mounts or in bottles, may be numbered on the mounts or numbered tags may be placed in the bottles. In addition to the numbers, a descriptive label should accompany each specimen, and while this label may be altered or arranged to suit your own ideas it should be quite complete and more or less as follows:

No.	Date................
Name	
Locality	
Collector	
Composed of...............................	
Uses	
....	

Such a label, when properly filled out, will add greatly to the value, interest, and attractiveness of the collection, for the observer may at a glance learn a great deal about the specimen. A bit of sulphur ore may not appear of special interest, but if the label shows that it came from Sicily and that it is used in making paper, sugar, gunpowder, sulphuric acid, medicine, disinfectants, etc., a real interest is added. Finally, remember that the greatest value of all collections and the strongest argument in their favor is that they teach something, and strive, therefore, to make your collections as educationally interesting as you possibly can.

CHAPTER III

FOSSILS

IN many ways collecting fossils is very similar to collecting minerals and quite often the two may be combined. Many minerals and rocks contain fossils, and nearly all fossils are found associated with minerals. Fossils are even more interesting and of greater educational value than rocks and minerals, for while the latter teach us a great deal about the formation and history of our earth the former tell us the marvelous story of the development of vegetable and animal life upon our planet.

It is through a study and knowledge of fossils that we have learned about the strange plants and remarkable monsters that once populated the earth. As nearly every branch of the animal and vegetable kingdom is represented among fossils, the boy who is interested in insects, animals, reptiles, or plants will find fossils fascinating things to collect and study.

Many people seem to think fossils are unworthy

of notice or consideration, but if it wasn't for fossils modern progress and civilization would be practically impossible. The coal with which we heat our dwellings, smelt our metals, operate steam engines, and perform the countless tasks of everyday life, is merely fossil peat, and in coal mines the fossil collector may find many beautiful and interesting specimens.

Practically the same tools are required for collecting fossils as for collecting rocks and minerals, and a very good plan is for two boys to work together—one specializing on fossils, the other on minerals—and thus each can help out the other, for the mineral collector will often find splendid fossils and the fossil hunter will frequently run across rare minerals.

In some localities fossils are very abundant, while in others they are very rare. Unlike minerals, fossils may often be found on plains or prairies or in swamps; and even on the great desert of Sahara fossils are abundant. It may seem strange to think of finding fossil shells, sea-urchins, and other marine creatures in the midst of vast dry deserts, but you must remember that these deserts were once seas and what are now sandy, barren

plains were formerly portions of the bed of the ocean.

In other places fossils are found in rocks and cliffs, and where limestone formations abound the rocks are frequently composed almost wholly of fossils of various kinds. Sometimes the rocks are made up of millions of fossil shells, cemented together by limestone, while in other localities the cliffs are composed of fossil plants, insects, and strange water animals. In still other places the apparently solid rock is in reality fossilized coral and when cut and polished such rocks show the construction and texture of the corals in a marvelous manner (Fig. 1).

In still other places one may find fossil shells (Fig. 2), sea-urchins (Fig. 3), corals, and various other objects lying loose in beds of sand, peat, or clay. Oftentimes these are as perfect and clean as modern shells upon the beaches, and in many cases the pearly linings and colors are still bright, although thousands of years have passed since they lived and crawled about upon the ancient seashores. Many times the real shells or other objects have entirely disappeared and only the mud or clay, which once filled them, remains. This mud or clay, how-

ever, has been transformed to stone and forms such perfect casts of the originals that it is difficult to distinguish them from the real shells (Fig. 4). When you find fossil shells, sea-urchins, or other marine animals loose in sand, earth, or clay you must not suppose they were fossilized among the loose material. Usually such fossils have been left free of surrounding rock by the matrix decomposing and wearing away through countless ages. The fossils being much harder than the rock itself resist the action of the elements and are thus left clean, perfect, and beautifully preserved.

Frequently, however, we find the fossil bones of extinct reptiles, fishes, birds, and animals buried in river banks, swamps, or other situations where rock never occurred. In such cases the bones have been fossilized while the surrounding material has remained unchanged. In ancient times many great reptiles and mammals (Fig. 5) became mired in swamps or broke through the ice on ponds and lakes and to-day their bones, in fossil form, tell the story of their death in the black muck of the peat bogs, or beneath the waters of lakes, which have long since disappeared. Sometimes the peat bogs or the beds of the lakes have become petrified and

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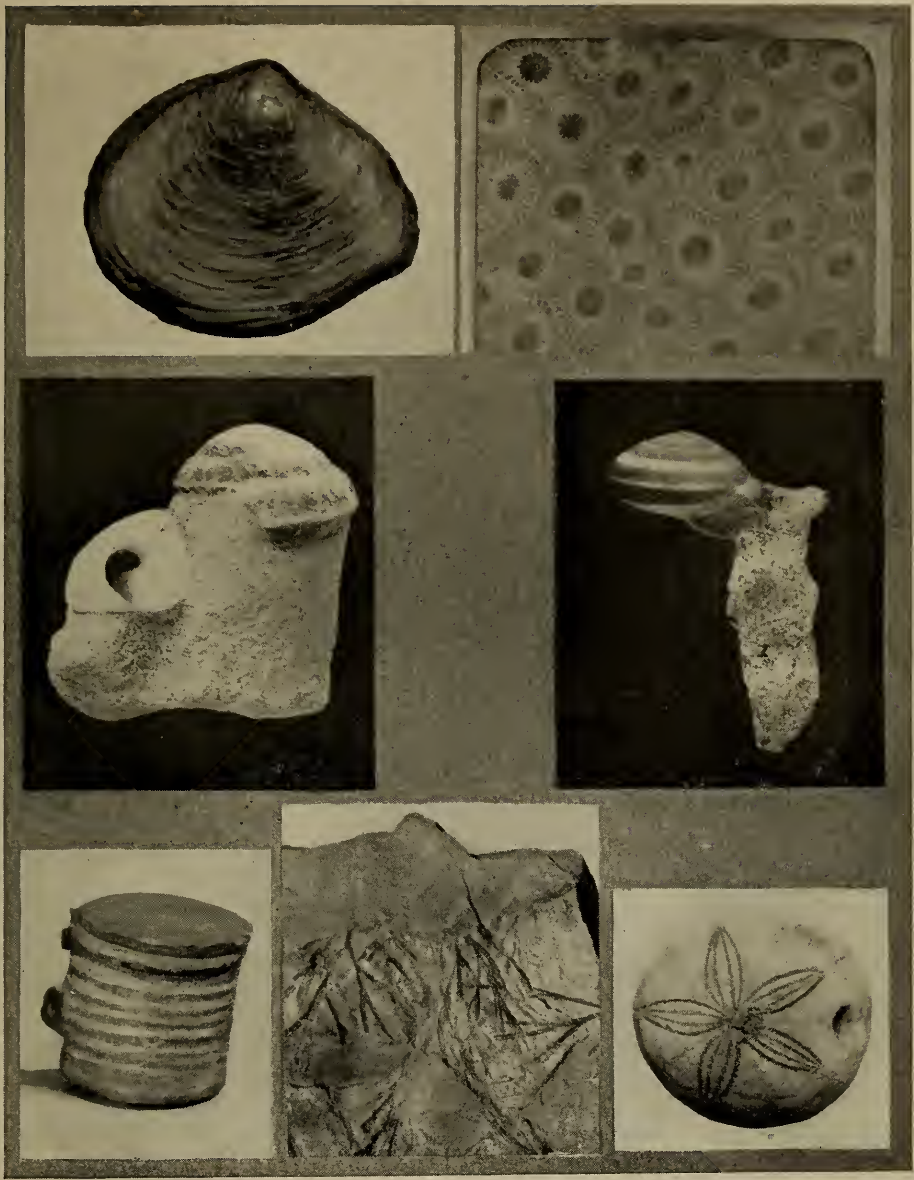


6

Fossils
(*See Chapter III*)

5—One of the Ancient Reptiles Which Left Footprints in the Sands

(*See Chapter III*)

the fossils are found imbedded in the chalk, limestone, sandstone, or shale. In coal mines, fossils are always found, and many splendidly preserved ferns, palm-nuts, leaves, and other vegetables may be collected by searching among the pieces of slate and shale thrown out at the breakers (Fig. 6).

Fossil fishes are very abundant in some districts and many of these are very perfect. In nearly all cases, however, the flesh and skin of fossil creatures has disappeared and only the bones remain and oftentimes the hardest portions of the skeleton, or the teeth alone, have been preserved. This is the case with fossil sharks' teeth, which are exceedingly abundant in some places. In the phosphate beds of our Southern States fossil sharks' teeth are found in great numbers and some of them are of enormous size. Such fossil teeth are also found at the bottom of the sea in some localities, and the United States Fish Commission steamers frequently dredge up these teeth by the bushel, when engaged in deep sea explorations.

Even such temporary things as rain-drops, wave-marks, and footprints have been preserved in the form of fossils. These are usually found in sandstone—especially the red sandstone of southern

New England—which once formed the beaches and sand flats of broad bays and shallow estuaries. Over these flats the great, weird beasts of prehistoric times wandered between tides, leaving their footprints upon the soft damp sand; showers dotted the sands with their drops, wind-blown leaves fell upon the flats, dead fish were left here and there by the receding tide, and the waves wrought little, wavy ridges upon the shores. Over these the rising water spread a thin layer of silt or mud and this, hardening to stone, preserved the marks beneath for all time.

To-day, hundreds of thousands of years since the wandering beasts, the summer showers, and the lapping tides left their marks upon these ancient beaches, we may break apart the firm, red sandstone and read the story written so long ago.

From all this you can readily see that you may find fossils of one sort or another in all sorts of places, although certain formations never contain them. Thus, old lava beds, basalt, granite, trap, and similar rocks of volcanic or igneous origin never contain fossils, but in districts where such rocks occur there are frequently deposits or beds of other materials which *do* contain fossils. In New Eng-

land, where the principal rock formations are of granite or trap, there are also deposits of sandstone and limestone and these are rich in fossils. So, in many Western States where the rocks are of basalt or lava there are often beds of sand, clay, or other materials in which fossils are found abundantly.

While many fossils are easily recognized by their resemblance to living forms, others are so different and so peculiar that they will often prove a puzzle to the young collector. Among such things are the stems of marine creatures known as "Crinoids." The perfect crinoid consists of a long, jointed stem with a pretty flower-like head at the summit and living species are known as "Sea Lilies" (Fig. 7). In ancient times these grew to gigantic size and covered the oceans' beds. Sometimes vast numbers of the fossil stems are found, either imbedded in rock or lying free in sand or clay, and in their fragmentary form they look like piles of lozenges or disks (Fig 8). It is seldom that an entire crinoid is found well preserved in fossil form and many a boy and man has been puzzled over the odd, jointed, stems which are so different from anything with which we are familiar.

While the majority of fossils are preserved in

limestone, sandstone, or slate—owing to the fact that they were originally at the bottom of rivers, lakes, or seas—there are others of a very different

FIG. 7. A modern Crinoid or "Sea Lily"

character. These, instead of being transformed to soft rock, have been impregnated with water containing silica and have been turned into the hardest quartz, agate, or jasper. This is very frequently

the case with trees, plants, and other porous objects, and the fossil trees of the wonderful petrified forest of Arizona are often very beautiful when cut and polished.

When collecting fossils great care should be used, for many fossils break very easily, while others become soft, crumbly, and cracked when exposed to the air. If fossils are in hard rock, a good sized block should be cut out and the superfluous rock may then be trimmed and cut away in your workshop and at your leisure. When fossils are in rock they are usually partly or wholly covered by the stone itself and to chip off this coating and expose the fossil often requires a great deal of skill and patience. Red sandstone, slate, shale, and some other stones separate very easily in regular layers, but other stones must be chipped away, bit at a time. The only tools required to accomplish this are a hammer and small cold chisels, while a bag filled with sand should be placed beneath the specimen as you work at it. Sometimes there is so little difference in color or texture between the fossil and the surrounding rock that you will find difficulty in telling which is which, but wetting it will often bring the fossil out in sharp contrast. If, while chipping

away the surrounding stone, a bit of the fossil breaks off don't throw it away, but preserve it carefully and later on cement the piece or pieces in place. After the fossil is well cleaned the surrounding rock should be worked down smooth and even and if there is little contrast between the stone and the fossil the former may be slightly tinted with some color dissolved in water or alcohol.

Many fossils, and especially fossil bones, are very fragile and may go all to pieces if handled carelessly. In such cases the fossils should be coated with glue or thin plaster-of-Paris before you remove them. Then, after they are safely in your workshop, they may be firmly imbedded in a plaster block, leaving one-half exposed and the temporary covering may be removed. Even badly broken fossils may be preserved and restored by imbedding the various pieces in plaster and filling in the cracks and missing portions with the same material. If the background is roughened with a chisel and tinted gray or brown it will look much like real stone and the fossil will appear as it did in the original rock. Professional fossil hunters often go to great trouble and expense to save apparently hopeless specimens and a common method of collecting

and transporting cracked or broken fossils is to wrap them in string, or strips of burlap, and then coat the whole with plaster. The rags or strings prevent the plaster from filling up the crevices or cracks and at the same time binds and stiffens the bundle. Thus treated, very fragile fossil bones may be packed on mules, horses, or burros and safely carried long distances under most adverse conditions. In fact, plaster-of-Paris is a very useful material for the fossil collector and every boy should become familiar with its use. Aside from its value in mending or protecting specimens it is often invaluable in making casts of fossils so large or bulky that they cannot be saved. Where a large fossil, or one firmly inbedded in the rock, is found you can make a plaster mold and from this you can make plaster, wax, or paper casts which will exactly reproduce the real fossil.

Fossils should be numbered and labeled like minerals and the larger specimens may be arranged in trays, drawers, or boxes. The very small things may be placed in bottles or glass-covered boxes and still other specimens may be mounted. A very neat way of mounting fossils—especially fossil shells, sea urchins or other objects which are rounded or

irregular in shape—is to mount them upon little columns or pillars of plaster. The column is easily made by filling a greased paper form or a small pillbox with plaster and just before the latter is hard the specimen may be placed in position upon it. When thoroughly hard and dry the paper or box may be removed and the plaster carefully trimmed and either left white, painted or coated with shellac (Fig. 9).

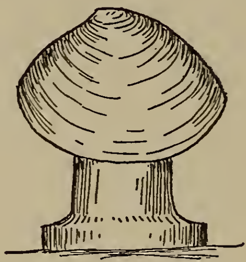


FIG. 9. Fossil shells may be mounted on little columns of plaster

Comparison with figures in books or with museum specimens will make the identification of most fossils easy and the more you collect and study them the more fascinated you will become in these petrified plants and animals of past ages.

Although most forms of life found as fossils are extinct to-day, yet others are identical with common living species. Still others prove how one form of animal or plant has gadually developed

from very different forms and such specimens are of the greatest interest and educational value. Birds with teeth and with long, fleshy, lizard-like, feathered tails are found in fossil form, as are also reptiles with many bird-like features; while among insects, plants, fish, and marine creatures there are countless forms which are true connecting links between groups, which in their present day form are widely separated and bear little resemblance to one another.

CHAPTER IV

PLANTS AND VEGETABLE SPECIMENS

AT first thought it may seem as if plants and vegetable products would be the simplest and easiest objects to collect. As a matter of fact, a great deal of care, skill, and patience is required to make a really good plant collection. The actual collecting *is* easy enough, for plants abound nearly everywhere and may be gathered with little or no trouble, but to preserve them, prepare them, classify them, and keep them free from injury or destruction is far more difficult.

Plants are so very numerous and botany embraces such a wide field that it is scarcely advisable for the young collector to attempt making a general botanical collection. It is far wiser to take up one particular branch at a time and make this complete and systematic rather than to attempt to collect a variety of objects, all of which may be included under the general term of vegetable specimens.

Roughly the botanical specimens may be divided into plants, flowers, leaves, seeds, and woods.

Each of these may be again subdivided, for the collector may specialize on a single group or division of any one. Thus, among the plants, we may form a collection devoted exclusively to grasses, ferns or some other group; we may confine our seed collection entirely to nuts, fruits, or some similar line; or we may make distinct collections of woods and bark.

Plants, Flowers, and Grasses

By far the most abundant botanical specimens come under this general heading, and when properly made and prepared, carefully labeled and well arranged, a collection of plants, grasses, or flowers is very interesting.

Many of our plants are of commercial or medicinal value and collections illustrating these characteristics are always instructive. Few people realize the large number of our common weeds which are used in medicine and a display of these will invariably arouse interest.

Wherever possible you should strive to secure the entire plant for the collection, for a plant bearing

leaves, flowers, and seeds, as well as showing the root and form of growth, will illustrate the species far better than if the various portions are collected and preserved separately (Fig. 1). Of course many things are so large that this method is not practical, and in other cases the seeds, flowers, or leaves are never found together on one plant. The only appliances necessary in collecting plants are a tin case or box (the standard botanical collecting tins are best), a jacknife, a small trowel, and an old blank book or a portfolio. For preserving your specimens you will need a number of sheets of good, white, blotting paper, some old newspapers, and a letter-press or plant-press or some smooth boards and heavy weights. For mounting and preparing your collections, clean, white, cardboard or Bristol-board and glue, are required.

You may collect plants at almost any season, but the best time is when they are fully grown and in bloom or in fruit. While carrying them home you should use care not to bruise, break, or injure them. Many things may be safely carried in the collecting box, but species which are fragile or which wilt quickly should be placed carefully between the sheets of your portfolio or blank book until you can prepare

them for drying. To prepare the specimens it is merely necessary to arrange them on sheets of blotting paper, place the sheets under weights, or in a press, and keep them there until thoroughly

FIG. 1

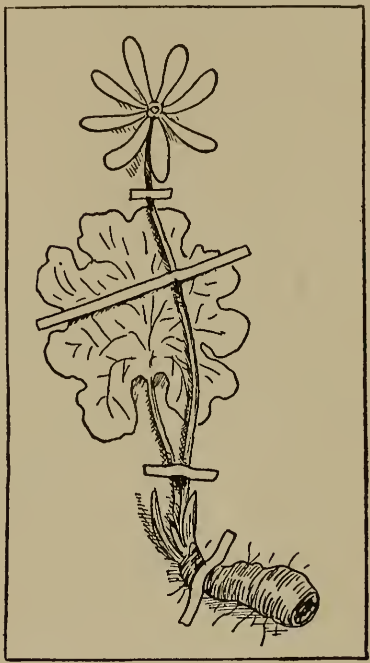


FIG. 2

FIG. 1. The entire plant should be gathered for the collection. FIG. 2. Pressed plants should be mounted by strips of paper pasted over them.

dried. It will be necessary, however, to change the sheets of paper frequently, for otherwise the specimens may mold, mildew, or even decompose, and the final success of the work and the amount of natural color retained in the plants will depend very

largely upon the attention you devote to carefully drying the plants and changing the papers. You may use special botanical paper for the purpose, but good blotting paper does just as well and even old newspapers will answer in most cases. Many species of plants and flowers will fade and become yellow and brown, no matter how carefully you dry them, but quite often such varieties may be perfectly preserved if they are dried on a dish of very hot sand or in an oven, or if they are soaked in a solution of formaldehyde before they are dried or pressed.

After the specimens are thoroughly dried they may be mounted upon white or tinted cards, either by fastening them in position with a little glue or by pasting little strips of paper across them as shown in Fig. 2.

Great care should be taken to number and label the plants correctly for many plants are very difficult to identify after they are dried and careless labeling makes any collection worthless.

Grasses are treated exactly like other plants, but are even easier to preserve, and a good collection of grasses is very attractive, as many of the species

are really beautiful in form, while a great many more are of commercial or industrial value.

Quite frequently good photographs of growing plants or grasses add a great deal to the value of a collection and colored drawings of the blossoms or fruits, or hand-colored photographs, invariably add to the interest and attractiveness of the botanical collections. These photographs and drawings may be attached directly to the card on which the specimen of the same species is mounted, or they may be numbered to correspond and kept separately. In the case of photographs of plants, or any other specimen, you should use black and white matt-surface prints and platinum paper, if possible. Glossy prints often reflect the light so that the picture becomes confused and gold or silver papers will often fade quite rapidly, especially when exposed to the action of chemicals and insecticides which are always in evidence in collections of plants, insects, etc.

Where it is desirable to illustrate some peculiarity of a plant—such as its method of seeding (Fig. 3), the various products made from it, or similar matters—it is an excellent plan to arrange the

FIG. 3. Plants which have peculiar seeding habits should be prepared to show such habits

specimens in glass-covered boxes. The well known Riker mounts are the best for this purpose and are very cheap, but any boy can make mounts which will serve just as well. The mounts are merely shallow pasteboard boxes with glass covers and are filled with layers of smooth, soft cotton. The specimens are arranged upon this cotton; the glass cover pressed firmly into place and the whole sealed and bound together by a strip of gummed paper fastened around the edges where the cover joins the box.

The boxes in which photographic dry plates are sold are very good for making these mounts, and old negatives, with the film cleaned off by the use of strong sal-soda and hot water, make excellent covers.

Light-colored specimens should be placed on dark-colored cotton and dark-colored specimens on white cotton. As these mounts are very useful for preserving specimens of many kinds, every boy collector should have a supply on hand. There is no better way of preserving insects, plants, dried marine specimens, delicate shells, and fossils and small minerals and crystals.

A very interesting and curious group of plants

are the fungi, more commonly and better known as toadstools and mushrooms. Many of these are very remarkable in form or are beautifully colored, but unfortunately most of them are exceedingly hard to preserve or prepare for collections.

Many of the rather dry, woody species, which may be found growing on trees, stumps, and logs, are easy to preserve by merely drying them in the air but they should be thoroughly soaked in a solution of formaldehyde in the first place as they usually contain the eggs or larvæ of insects and, moreover, are attacked by numbers of household insect-pests. Even if this is done the tiny book-lice, weevils, ants, and buffalo bugs often ruin the fungi and the safest method is to keep the specimens in tight cases or boxes with camphor or naphthalene.

Many of the softer fungi can only be preserved in alcohol or in formaldehyde solution, while still others may be dried by first soaking them in formaldehyde and then drying them on hot sand or in an oven. A great many kinds cannot be properly preserved by any of these methods, and even when well preserved some species lose all their natural colors and beauty. Wax casts, made as directed for fruits, will often prove far more satisfactory

than the real fungi, while photographs or colored drawings will often serve every purpose and will prove more interesting and attractive than the actual specimens.

If you *do* collect fungi be sure to handle them carefully, for if bruised or broken they turn dark colored and spoil very quickly. Only fresh, young specimens should be collected, for if they are old or have commenced to decay you cannot do anything with them. As soon as gathered they should either be dropped into jars of formaline or else wrapped carefully in fine tissue paper and cotton until you reach home.

Although collecting and preparing plants and similar specimens is simple and easy, your work is by no means over when this has been accomplished. Pressed or preserved plants are very easily injured and numerous insect pests destroy them, unless precautions are taken. Although they are not attacked by the clothes-moths, dermestes, and similar things, which play such havoc with animal matter, feathers, cloth, etc., yet they are very attractive to book-lice, roaches, minute beetles, weevils, and many other insect-pests. Soaking the fresh plants in formaline often helps guard against these insects,

but to insure safety they must be kept in an atmosphere redolent of camphor or naphthalene and must be frequently examined.

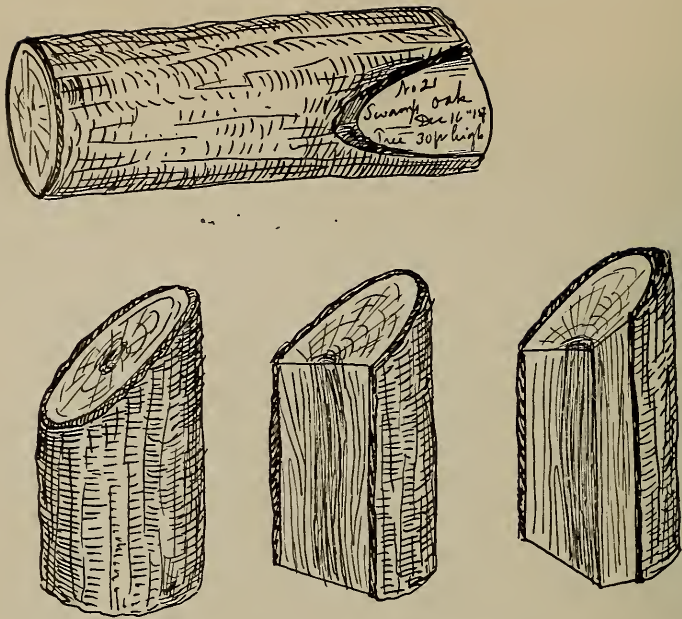
Possibly your greatest trouble will be in properly identifying and classifying your plants. Almost any good botany will help you in this work and the many illustrated popular works on wild flowers and other plants will be found most useful. If you are really interested in plants you will find studying them and identifying them the most enjoyable part of the work and if you are not enough interested in plants to take the trouble and time necessary to classify and identify them you should not attempt to make the collection.

Woods

Of all these groups perhaps the collection of woods is the easiest to make, as well as the most instructive and interesting. Moreover, woods are readily preserved, they are not easily injured, and they are well adapted to exhibition and study purposes, which cannot be said of flowers, leaves or many other botanical specimens.

As in the case of every collection, the value and interest of the wood collection depend very largely

Plant Mounted to Show Habits of Flowering
(*See Chapter IV*)



5—Various Steps in Cutting Wood Specimens

6—Specimens of Wood Finished
(*See Chapter IV*)

upon the care with which the specimens are collected and prepared and the accuracy with which they are identified, classified, and labeled.

There are many species of woods in nearly every locality and yet very few people can distinguish more than one or two varieties, even after they are cut and polished. Still fewer of us are able to identify the trees by their bark, forms of trunks, methods of branching, or by the fruits, seeds, or leaves, and even if we know the trees in summer we will often find it difficult to tell them apart in winter, after the leaves have fallen. For these reasons the wood collections are of real educational value, for if well arranged the specimens will illustrate the distinctive characters of the various trees far better than printed descriptions or illustrations in books. The collection should not only be arranged to show the natural characters of each bark, tree, and the grain of the wood, but it should also illustrate the characteristics which adapt the various woods to certain uses. The wood collection may be made at any season, but it is just as well to collect most of the specimens during the winter when other things are hard or impossible to collect and thus have the warmer months free to devote to

other objects. The only tools required in collecting woods are a small, sharp saw, and a hatchet or ax, but for preparing the specimens you will require a plane, a chisel, sandpaper, shellac or varnish and glue.

The specimens need not be large, but very small specimens should be avoided and you should aim to secure medium sized pieces, say three or four inches in diameter and six or eight inches long and try to have all the specimens as nearly the same size as possible.

You may cut the specimens from living trees—selecting straight, well-grown branches—or splitting pieces from larger limbs or trunks, or you may obtain a large proportion of them from wood piles, saw mills, lumber yards, etc.

Cut the piece selected about a foot in length, leaving the bark in place. Just as soon as the billet of wood is cut it should be marked with a pencil in order to identify it. The mark may be merely a number and a corresponding number in a note-book may be filled out with the name, locality, and date, or these various items may be written directly on the wood. The best way to do this is to chop or whittle away a smooth space on the wood and write

on this with a carpenter's pencil (Fig. 4). The pieces of wood should be placed in a cool, dry spot to season and they should be turned over from time to time as they dry. Oftentimes the bark may be loose, or may warp or peel from the wood as it dries and when this occurs it should be secured in position by a piece of string or twine until you are ready to prepare the specimens for the collection when the bark should be glued in place.

A very important matter in a wood collection is to show the natural bark and the character of the wood in various sections, and the best way to do this is as follows: When thoroughly dried saw off one end of the piece true and even and saw off the opposite end at an angle or diagonally. If you can obtain a miter-box this work will be greatly simplified and all the specimens may be sawed at exactly the same angle (Fig. 5A). The next step is to divide the piece of wood longitudinally through the center. This may be accomplished by sawing or splitting, but as wood does not always split true the former method is the better (Fig. 5B). The diagonally cut end and the split or sawed side should then be planed and sandpapered smooth and a small space should be planed away on the right

hand side (Fig. 5C). The specimens will now appear as in Fig. 5D, and will show the bark, a cross section, the grain from heart to sap-wood, and a quartered section in their natural, unfinished colors. In order to illustrate the appearance of the wood in a finished state a small portion at the base (the square end) and one-half of the diagonal end should be varnished, and the piece may then be mounted, labeled, and arranged in the case or cabinet. There are various ways of mounting wood specimens, the simplest being to tack a piece of stiff cardboard to the base with a tack or small nail driven into the wood from the lower side of the card. The specimens should be arranged with the cut surface in front and the specimens should be grouped according to the relationship of the various trees. Thus all the pines should be placed together, all the oaks in another group, the walnuts in another, and the fruit trees in still another. There will still remain a number which have no very closely related species, and these may be arranged according to whether they are hard or soft woods.

A neat label should be fastened to the mount of each piece with the name, locality, date, etc., as

well as the size of the tree from which the specimen was obtained and a note regarding the purposes for which the wood is ordinarily used (Fig. 6).

This collection of pieces of wood alone will prove very interesting and instructive, but its value may be greatly increased by showing the leaves and seeds of the tree with the woods. A still greater interest and value may be added by the use of good photographs of the trees themselves.

If you intend to show photographs you should try to select trees standing by themselves and you should have one picture showing the tree in summer and another of exactly the same size and taken from the same spot showing the tree in winter (Fig. 7).

Even if the pictures are not shown with the specimens they will be of value and a collection of such photographs is in itself very interesting.

The seeds or nuts of most trees are very easy to preserve and simply require drying. Some, however, will ripen or burst open after they are collected and dried and to prevent this they should be either boiled in water or soaked in strong alcohol or formaldehyde solution. The latter is the best

method, for it preserves the seeds and also prevents insects from attacking and injuring them.

When the nuts or seeds are contained in shells, pods, or burrs the complete covering containing the seeds should be preserved and shown as well as the seeds or nuts after they are removed.

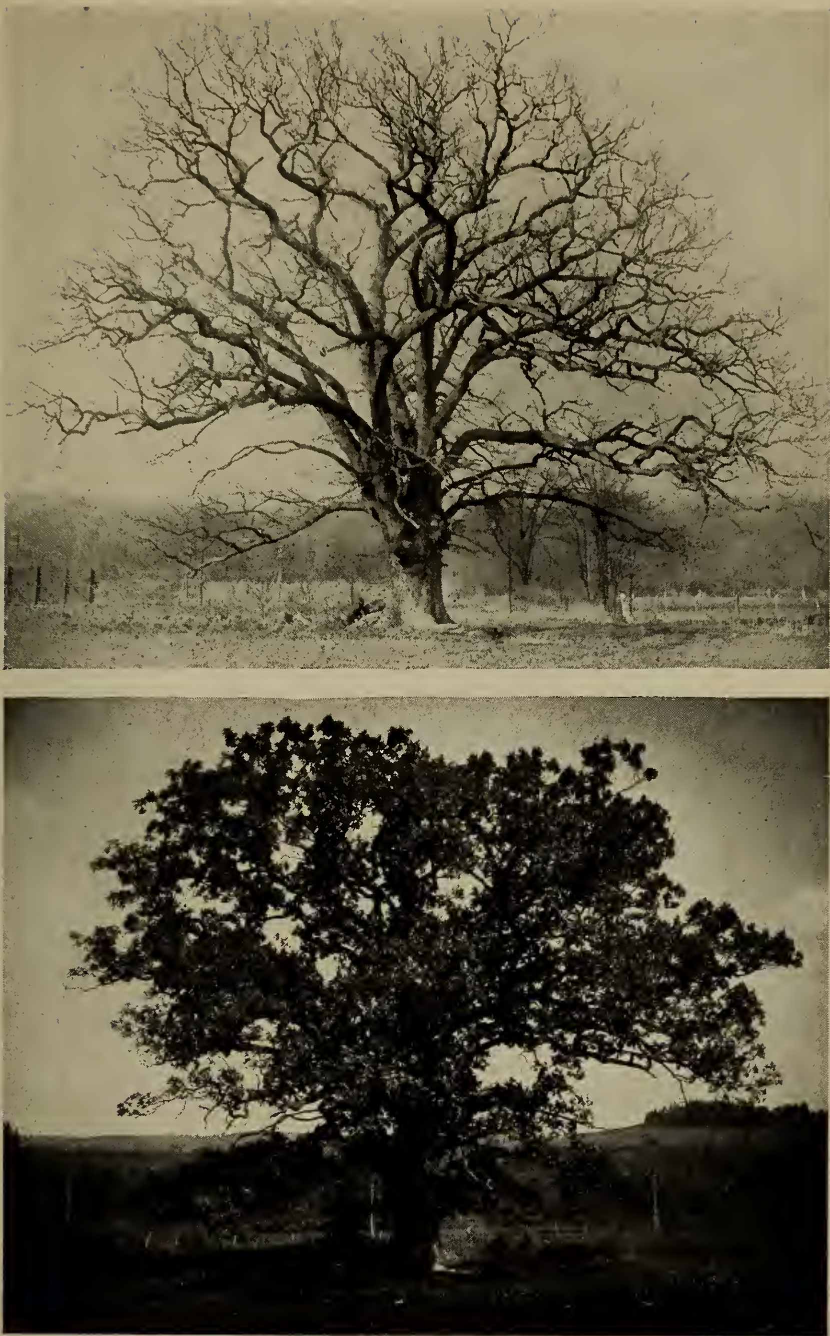
Many trees bear soft berries or fleshy fruits which shrink and shrivel up when dried and in order to exhibit these to advantage they must be preserved in alcohol or formaldehyde, or wax casts must be made as described in connection with the fruit collections.

Leaves

The leaves may be real leaves, dried and prepared by pressing them between paper or blotters, or they may be solar prints or autographic prints. As dried leaves are very fragile and are easily injured the prints are preferable, and in most cases they show the true character of the leaves far better than the dried specimens.

Solar prints (Fig. 8) are very easy to make and reproduce every vein, rib, and detail of the originals with the greatest accuracy.

The only appliances required to make these



7—The Same Tree in Winter and in Summer
(See Chapter IV)

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8

8—Solar Print of Leaf. 9—Photographs of Leaves. 10—Lace of the Lace-Bark Tree

(See Chapter IV)

prints are a photographic printing frame, a glass to fit it, and the sensitized paper. The ordinary blue-print paper is excellent, but Solio or any other regular printing-out paper will do very well. To make the print, place the leaf upon the glass of the printing frame, lay a piece of the paper over it, place a piece of thin cardboard over this and clamp the back of the frame in position and expose to bright sunlight. If blue-print paper is used expose until the paper around the leaf is very dark bronze and then remove and wash in cold water until the white portions of the print are clear and sharp and the exposed portions are rich blue. If Solio or other papers are used the printing should be very deep and the paper should be toned and fixed as usual. The exact length of time for the exposure must be determined by experiment and, moreover, it will vary with different leaves. Thick, fleshy leaves will require a much longer exposure than thin ones, but the idea is to expose until the sunlight has penetrated the thinner parts of the leaf, leaving only the ribs or veins pure white, as shown in the illustration.

The autographic method of making leaf prints is very different and is in some ways much simpler.

For this process you will require a rubber roller, such as is used in mounting photographs, some tube oil-colors or some printers' ink, and some stiff, white paper or Bristol-board. To make the print place a fresh leaf upon a card or paper and brush it over smoothly and evenly with a coating of ink or paint.

Be careful and do not put the material on too thickly, but be sure to cover every portion evenly. Lift the leaf carefully and place it, inked side down, on a clean sheet of card or paper, cover it with a piece of soft paper, hold the stem in position with one finger pressed upon it over the covering paper and run the rubber roller firmly over the whole. The covering paper should then be carefully removed and the leaf lifted by the stem and you will then find that a perfect and beautiful imprint of the leaf has been transferred to the card beneath. If you have a letter copying-press you may secure even more perfect autographs of the leaves by placing the inked leaves in the press and screwing it down tightly. Care must be taken to have the leaf upon a level surface, with a pad of old newspapers or a thick magazine beneath. You may have to make several trials before you acquire the knack

of making a good clear impression without smudging the print when removing the cover paper and leaf.

These autographic prints may be made in any desired color and they are particularly attractive when printed with deep green ink as in this color they closely resemble the real leaves. Moreover, dead or dried leaves may be perfectly reproduced by these methods and oftentimes these show the veins and details better than the fresh green leaves. The boy who posseses a camera may also make photographs which will serve every purpose for the collection (Fig. 9). Arrange the leaves on a piece of clean glass, support this some distance above a perfectly white background, and place the camera vertically above them. In this way all shadows will be avoided and excellent, even lighting may be obtained. Another method, which also gives excellent results is to place the leaves on a white card in a printing frame with a glass cover. This obviates the necessity of placing the camera vertically, but it is sometimes difficult to prevent the reflections on the glass from showing in the photograph. Moreover, thick, fleshy leaves, or those with coarse stems, will throw quite distinct shadows

which will confuse the real outlines of the leaves.

In collecting the leaves, whether to exhibit dried, to photograph, or for solar or autographic printing, you should secure those of medium size and typical form. Many plants have leaves of several distinct forms and in such cases each form should be shown. Grapevines, mulberry trees, and sassafras are notable examples of this class of plants, and oftentimes the leaves taken from different portions of the same plant or tree will be so distinct that you would never suspect they were of the same species. When the woods, leaves, and fruits are all ready they may be mounted together on pieces of stiff card or on thin wooden stands and a neat label should then be fastened to the mount. The exact form or wording of the label may be varied to suit your own taste, but the general form should be about as follows:

No.------- Locality------------------
Name------------------------------------
Found in---------------------------------
Height-------Diam--------Circum--------
Qualities of timber------------------------
Used for----------------------------------

If photographs of the trees are to be shown with the specimens they may be placed behind the mounted woods. Sometimes trees have such distinctive flowers that they are worthy of being shown with the wood specimens. Flowers, especially those of trees, are very difficult to preserve and the best method of showing them is to use good photographs or drawings. If you have but little space to devote to the wood collection you may exhibit the woods and seeds only and arrange the photographs, prints, etc., in an album with each species numbered to correspond with the wood specimens.

You will find that collecting woods will prove very interesting work and by collecting the fruits, flowers, and leaves also you will soon learn to recognize all the native trees by any one of their various parts as well as by their form. Many of the commonest trees have very interesting habits, methods of growth, and peculiar properties, which are known to but few people. Strange as are many of the native trees, you will find some of the foreign species even more remarkable, and after you have secured a good collection of native woods you can look farther afield and obtain specimens by exchanging with other collectors.

For example, there is the silk-bark tree of South America. The inner bark of this tree is as soft, white, and delicate as real lace and in the countries where it occurs it is used for various household purposes in place of cloth. In order to secure the tree-lace the branch is cut or broken off, the outer bark removed and the inner bark unrolled. Sheets thus obtained are frequently over a yard square and are used by the South American girls and women as veils, handkerchiefs, napkins, mosquito-netting, portières, sheets, and clothing. The bark appears thin, delicate, and fragile, but in reality it is very tough and strong, and when braided or twisted it is used for twine, rope, hammocks, harness, etc. Oftentimes the natives strip away a portion of the outer bark, unroll the lace-bark, and braid it together, and in this way make very durable and cheap whips. In fact, the lace-bark is a most useful natural product and in some places suspension bridges over rushing mountain torrents are made entirely of ropes formed by twisting and braiding this cloth-like bark. So common and cheap is the natural lace that garments made of it are seldom washed, for the natives find it easier to secure a fresh supply from some convenient tree

Photographs to Show Seeds and Flowers of Trees

than to bother laundering that which has become soiled. A specimen of this strange tree should be in every wood collection for it is one of nature's marvels (Fig. 10). Many other foreign woods are of great interest and it is a good plan to have specimens of such well-known woods as mahogany, ebony, rosewood, etc., if only for comparison with native varieties. If the boy collector is fortunate enough to travel to foreign lands he may obtain many interesting specimens and there is no class of specimens which is easier to collect and carry home than the woods, leaves, and seeds of trees. Even if you do not travel, there is little difficulty in obtaining a very good collection of foreign woods with the leaves of the trees. The wood itself can readily be obtained from cabinet makers, furniture, or piano factories or similar places, and a botanical garden will usually furnish the leaves. As dead or fallen leaves are just as satisfactory as green ones there is no objection to gathering them and nearly every botanical garden has specimens of the more important cabinet and dye wood trees, as well as many of the tropical fruit trees, medicinal trees and plants, and other interesting botanical specimens.

Casting Fruits

A very attractive and interesting portion of the botanical collection is the fruit exhibit. Although fruits themselves are almost impossible to preserve satisfactorily, it is an easy matter to make wax reproductions which serve every purpose and are indistinguishable from the real fruits when carefully made. Such common and well-known things as apples, pears, peaches, etc., are scarcely worth bothering with unless you wish to show them in connection with the woods, but many of the wild fruits, berries, and foreign fruits are so important, so odd, or so handsome, that they are worthy of a position in your collection.

You will find making casts of fruits and other objects very interesting work and as molding and casting is a very useful art and is frequently used in making collections, I advise every boy to learn how to cast and mold properly. There is nothing much simpler to start on than fruits, and few objects will give better results.

The materials required for making the casts are plaster-of-Paris—the fine dental grade is the best—some paraffin, beeswax, Japanese wax, or bay-

berry wax and spermaceti, as well as some common modeling or potters' clay and some tube oil-colors or dry, powdered colors. For your first attempts at casting select some round, or nearly round, fruit with a smooth surface, such as an apple, pear, or orange. Mix up a quantity of clay with water until it is soft enough to work easily, but does not adhere to your hands or other objects—about the consistency of good putty is right—and in fact putty may be used in place of the clay if preferred. Some of the patent modeling compounds such as "Plasticene" are even better than clay, but the latter is cheap, it can be obtained anywhere, and it will serve every purpose.

Clean the fruit to be cast and embed it in a good bed of clay or similar material until the clay extends up to the thickest portion of the fruit as shown in Fig. 11. In accomplishing this use great care, for if the clay bed extends beyond the greatest diameter, or does not reach to it you will be unable to make a satisfactory mold or cast.

Wipe off any particles of clay or dirt which may have adhered to the portion of the fruit left exposed and then build a little wall or fence of clay around the bed a short distance from the fruit and

a trifle higher than the uppermost portion of the fruit.

The next step is to mix the plaster-of-Paris with water, stirring it constantly and adding plaster, until the mixture is smooth and free from lumps and is about as thick as good cream.

With an old spoon, or a ladle, dip out the plaster and pour it over the fruit until every portion is covered and the plaster completely fills the space between the fruit and the surrounding walls of clay.

The plaster will set quite rapidly and as soon as it commences to harden pile more on top of the mass until quite a little mound is formed above the fruit (Fig. 12). Before doing this, jar the mold several times by striking the table or other object upon which it rests in order to cause the plaster to settle into all the crevices and to eliminate air bubbles which might otherwise form.

Leave the mold until thoroughly hard and then turn it upside down and pull away the clay base and wall. You will then find that your fruit is embedded in a white plaster mass with one-half of the fruit exposed as in Fig. 13. Set this evenly and securely in a mass of clay and with a small-bladed

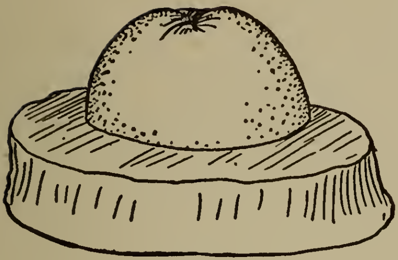


FIG. 11

FIG. 12

FIG. 13

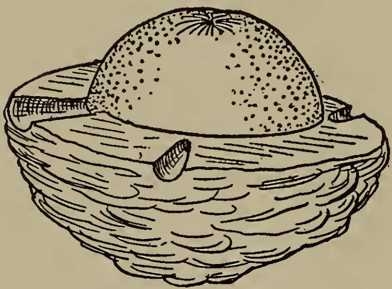


FIG. 14

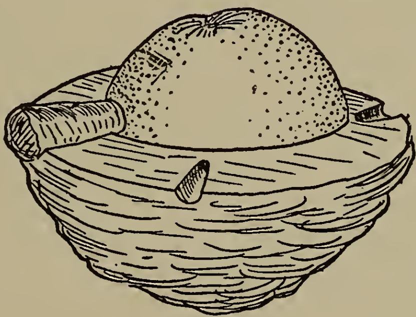


FIG. 15

FIG. 11. The fruit set in clay bed. FIG. 12. Fruit in clay bed covered with plaster. FIG. 13. First half of mold with clay bed removed. FIG. 14. First half of mold showing notches cut in sides. FIG. 15. First half of mold ready to make second half

knife cut two or three notches around the edges of the plaster, with a larger and deeper notch extending from the edge of the plaster to the fruit (Fig. 14). Form a little conical roll of clay and place this in the large notch so that just one-half extends above the edge of the plaster as shown in Fig. 15, and then give all portions of the plaster a coat of paraffin (dissolved in gasolene), thin shellac, neat's-foot oil, linseed oil, or thin vaseline or other grease; but taking care not to smear the grease or other substance upon the surface of the fruit. With the clay, or modeling material, construct a wall all around the edges of the plaster and extending above the highest, exposed part of the fruit and mix some fresh plaster and fill up the space and pile plaster above the fruit as you did in forming the first half of the mold. When the plaster has thoroughly hardened, which should not take more than an hour or two, take off the clay wall and pull gently on the two halves of the mold. If you have used care and have followed my directions the two parts will readily separate, leaving the fruit in one of the halves of the mold. Wiggle and pull the fruit gently until it slips from the plaster matrix, extract the cone of clay in the notch and

carefully remove any chips of plaster, bits of clay, or other foreign matter from the two portions of the mold. Oftentimes you will find little holes or imperfections on the inside of the mold and these must be very carefully filled with tiny pellets of clay pushed into them with the end of a soft wooden stick or toothpick. Now fit the two halves of the mold together—which is easily accomplished by matching the notches and the projections on the two portions—and secure them in position by wrapping string, twine or thread about them.

You are now ready to make the wax cast and the first step in doing this is to mix the several kinds of wax together in the proper proportions. The best way to do this is to melt together equal quantities (by weight) of hard paraffin and beeswax, and add a little Japanese wax and some spermaceti or bayberry tallow, or both. Stir the mixture thoroughly and while still hot pour a little on a piece of hardened plaster. When this is cool and hard try to peel it from the plaster. If it pulls away readily and is tough, hard, but not brittle, the mixture is right. If, on the other hand, it sticks to the plaster or is soft, sticky, or flexible, more Japanese wax and bayberry wax must be

added. If it breaks and appears brittle or cracky, add more beeswax and paraffin. If hard and tough, but sticky, add paraffin only. Each of the various kinds of wax has certain properties and once you learn these you will be able to determine just which the mixture lacks. Beeswax makes it tough, but sticky; paraffin prevents the wax from sticking but makes it flexible and soft; Japanese wax makes it hard and gives it a body, besides causing it to take a very fine impression; bayberry wax also adds body and hardness but is rather brittle, while spermaceti causes the mixture to harden evenly and rapidly and prevents the wax from shrinking as it cools.

When the mixture is right, stir some powdered color, or a little oil color, into the wax and drop a little of the mixture on a piece of white paper or plaster. The color used will depend upon the fruit you are molding. For oranges use orange-chrome or chrome-yellow, for green fruits chrome-green, for red fruits carmine, vermilion, scarlet, etc., and for fruits which have two or more colors use the color which predominates and after the cast is finished the other tints may be added by hand.

When the wax is mixed and colored satisfactorily, pour it into the conical opening in the mold

until the latter is about three-fourths full. Plug the hole with a piece of soft clay and grasping the wax-filled mold in your hands commence turning and twisting it about in every direction. Continue to keep the mold in constant motion until the wax remaining in the receptacle in which it was melted has commenced to harden. When this has hardened you may feel sure that the smaller quantity in the mold is thoroughly hard and you should then drop the entire mold into cold water, and cut through the threads or strings which bind the two halves together. After a half-hour or so, grasp the two halves of the mold and wiggle them gently back and forth until a slight looseness is noticed. Then place the mold again under water, continuing to work gently at the mold until one-half or the other comes away, leaving the wax cast of the fruit exposed for half its diameter. This wax cast is hollow and very fragile and you must be very gentle and careful if you are to remove it from its matrix without injury. By keeping it submerged in cold water and by pushing and working at it carefully the cast will at last come free of the plaster and you will have a perfect wax duplicate of the original fruit. Here and there you will find

little "fins" of wax on the cast and these must be carefully trimmed off with a sharp knife. There are usually a number of small bubble-holes and other imperfections in these casts and when the wax has been dried and freed from water on a soft cloth these various defects must be filled by heating a small knife-blade, dipping it in some of the remaining wax and molding the material into the holes. If the wax cast requires further coloring it can be easily done by rubbing on a little tube oil-color, or a little dry color mixed with turpentine, with a soft brush or a tuft of cotton. By using a little color at a time and rubbing it in carefully you will find that you can blend the tints perfectly and give a very natural effect to the wax cast.

Of course your first attempt may be a dismal failure. The wax may adhere so firmly to the mold that you cannot separate the two halves without breaking the wax cast, or one-half may come away and yet leave the wax so firmly attached to the other half that you cannot remove it without injury. Then again you may find that one side of the wax cast is thick and the other side as thin as paper or there may be concave or shrunken places on the cast. Sometimes, too, you'll find that the

wax has formed uneven layers and spots or is covered with holes and imperfections. Each of these troubles is due to some definite cause and each may be easily overcome. The wax seldom sticks to a new mold, but if the plaster becomes thoroughly dried out before the wax is poured in, or if an old mold is used, the wax frequently adheres to the plaster and ruins the mold. This can be avoided by soaking the plaster molds in water before pouring in the wax or by using them before the plaster has become bone dry. If one-half of the mold comes off easily and the other side sticks fast you may be sure that the fault lies in the mold. If care has not been used in making the dividing line between the two portions of the mold exactly at the widest part of the fruit the cast will not come free and if there are indentations or irregularities on the fruit the same trouble will result. If one side of the cast is thick and the other thin you may feel sure that you did not keep the mold in constant motion or else that you left the wax-filled mold standing too long before you commenced to move it about. If there are concave or shrunken spots on the cast it is due to the fact that too little wax was poured in. The irregular layers or lines, or the

indentations and imperfect spots, are caused by the wax being too cold when poured, or to the mold being too cold or too wet. In any case the remedy is obvious and all you have to do is to remelt the wax and try again, although if the wax has stuck to the plaster and cannot be peeled off a new mold must be made.

Although it is a very simple matter to make molds and casts of regular, almost-round fruits, as above described, you will find that it is much more difficult to cast various other objects which are irregular in form. As many of these are very interesting and as the work of making casts is really fascinating, the young collector should learn to cast objects of various forms after he has mastered the principles of molding the simpler things such as oranges or apples. Not only fruits, but various animals, fishes, fossils, and countless other objects may be cast in wax, metal, plaster, etc., and the method of making the molds is similar in every case. The simple mold in two halves is only adapted to objects with a very regular outline and which present almost perfect ovals or circles in cross section.

In order that the mold may come away from the

object freely each portion must have a larger opening at the bottom than at the top and this can only be accomplished with two pieces when the object molded is circular or oval. If there are various indentations, angles, or irregularities on the object, the mold must be planned in such a way that each piece covers only a segment of a circle or oval. This may be better understood by referring to the illustrations. In Fig. 16 a section through an apple or orange is shown and you can readily see that if this is enclosed in a mold made in two pieces each half will come away easily as in Fig. 17. In Fig. 18 a section of a muskmelon is represented and you can see that in this case a mold made in two parts could *not* be withdrawn, owing to the projecting ribs on the fruit as shown in Fig 19. In order to overcome this trouble we must make a mold in several sections as shown in Fig. 20 or else we must cast the melon "end on" as shown in Fig. 21, in which position a two part mold will answer. Such projections or irregularities are known as "undercuts" and the whole secret in making good plaster molds of objects of any sort lies in planning the molds so that there are no undercuts. Not infrequently a mold is made in a dozen or more sep-

arate pieces and even the common apple will be much easier to cast in a three-piece mold than in one of two pieces, for apples, oranges, or pears often have undercuts which must be avoided. In the case

FIG. 16

FIG. 18

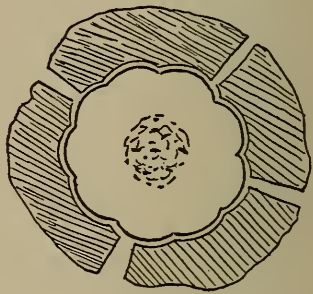


FIG. 20

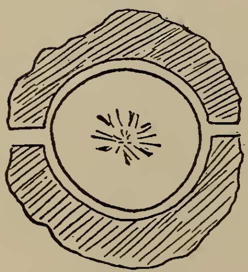


FIG. 17

FIG. 19

FIG. 21

FIG. 16. Section of a fruit which can be cast in two-piece mold. FIG. 17. Section of two-piece mold and fruit. FIG. 18. Section of fruit which requires mold in several parts. FIG. 19. Section of a two-piece mold on irregular fruit showing undercuts. FIG. 20. A mold of an irregular fruit made in several pieces. FIG. 21. How to cast an irregular fruit end on

of the apple or orange the two-piece mold made with the fruit vertically will do very well, but if we wish to cast a pear we will find a three-piece mold necessary to obtain good results. In this case the pear

should be molded by placing it side down on the clay bed, but before pouring the plaster over it a space must be built up at the flower end of the fruit as shown in Fig. 22. After the first half of the

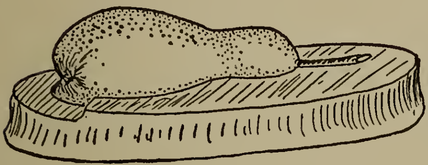


FIG. 22

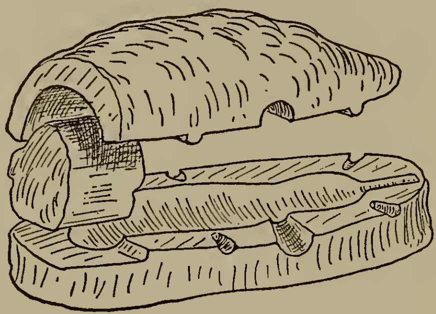


FIG. 24

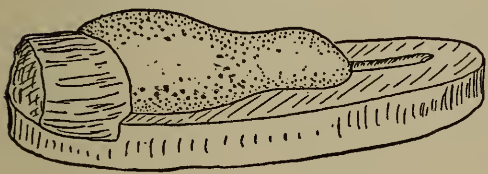


FIG. 23

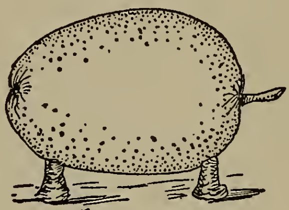


FIG. 25

FIG. 22. The first step in making a three-piece mold. FIG. 23. Next operation in making the mold. FIG. 24. The mold complete. FIG. 25. Fruit ready to mold in gelatine

mold is made and the clay bed has been removed more clay should be built up at the end of the pear as shown in Fig. 23 and the second half of the mold should be made as already described. After this is hard, and before removing the pear, the clay

at the end should be carefully taken out and the space filled with plaster (after first greasing the plaster mold). Then when all is hard, the two main halves may be separated and the third piece drawn from the pear as shown in Fig. 24, thus overcoming the troublesome undercut at the end of the fruit.

It is in thus planning the arrangement and number of pieces in each mold that real skill in casting lies and the only way to learn just how to make casts of various objects is to use common sense and judgment, and experiment until you have mastered the art.

Many very irregular objects may, however, be cast without the trouble of making molds in several pieces. This is accomplished by using glue or gelatine in place of plaster in making the molds. The object to be cast by this process is first rubbed with sweet oil and is placed in position by means of fine wires or pins or even little pillars of clay (Fig. 25). A wall of clay is then built around it and melted gelatine or glue is poured over the whole. When the gelatine is hard a slit is made, extending from the surface of the mold to the object within, and through this the latter is pulled. An opening

is made, through which to pour the material for the cast, the gelatine mold is tied together or clamped in a plaster form molded about it and the plaster or other material is then poured into the mold. The flexibility of the gelatine permits the removal of the original object as well as the finished cast, regardless of undercuts, but the process has many disadvantages. In the first place it is a rather hard matter to combine the glue or gelatine and glycerin in just the right proportions to form a tough, flexible, and clean-cut mold, and in the second case gelatine molds are not adapted to casting in wax or any other hot material. Plaster-of-Paris is practically the only material which can be used in making the casts and this is far less satisfactory than wax for many purposes. Moreover, glue molds can only be used a few times and do not keep indefinitely and taken as a whole they are not to be recommended for amateurs' use if really good results are desired.

CHAPTER V

INSECTS

OF all groups of the animal kingdom probably none is of more importance to mankind or has a greater influence upon our lives than the insects. Among the vast hordes of insect life we find some of our worst enemies and many of our best friends. Enormous industries, great factories, and countless mercantile establishments would be impossible were it not for the humble silk-worm; the fig orchards of the world would be unprofitable without the aid of a tiny fly; and the wonderful fruits of California would have been destroyed, had not man sought the help of a little beetle.

On the other hand tremendous areas of growing crops and countless millions of dollars' worth of agricultural products have been devastated and destroyed by insects. Famines and pestilence have followed in the wake of insect-pests and more human beings are annually killed by insects than by poisonous serpents or wild beasts. Indeed, of such

tremendous importance are these despised creatures that it is doubtful if the human race could exist without them, for the production of seeds by plants depends largely upon insects which carry the pollen from one flower to another.

The incalculable importance of insects makes insect collections both interesting and valuable, and until you actually begin to study and collect them you cannot realize how many kinds are found in one locality or how fascinating are their habits and how beautiful or remarkable their colors and forms.

While thousands of species of insects have been classified and named and the habits of immense numbers are well known, yet new species are being discovered constantly and their wonderful habits and strange life-histories are being studied and described by entomologists.

For these reasons insects possess a peculiar fascination, especially for boys, for you never know when you may find a new species or may learn some unexpected and unknown habit which will prove of immense benefit to the world.

Insects are easy to collect and preserve, but in order to collect them successfully you must know something of their haunts and habits and must use

a great deal of patience, perseverance, and care. Insects of one kind or another are to be found nearly everywhere and at all seasons of the year, and the ardent insect collector must ever keep on the alert to discover specimens to add to his collection. It is during the warm spring and summer months that insect life is most in evidence, however, and to the interest and enthusiasm of collecting is added the healthy, enjoyable life in green fields and shady woodlands.

Each season and each locality has its particular insects and oftentimes these are in evidence for a very short time. Many insects have a very brief life of but a few days or hours, while others live for months or even years. If you are to have anything like a complete collection you must take the specimens as you find them and must be prepared at all times and in all places. Insects are so numerous, however, that it is practically impossible for a boy to make a general collection embracing all the groups, and it is a far wiser plan to confine your collection to one particular group, or to a few groups, and when these are fairly complete to commence on another. But while collecting one class of insects you should not pass by others that cross

your path. If you are collecting butterflies and have a chance to collect a fine moth or beetle, secure it by all means—like as not you may never see a specimen of the sort again, for insects, like many other wild things, have a most exasperating habit of being common when you don't want them and then becoming suddenly rare when you try to obtain them. Moreover, many insects fairly swarm at times and then disappear entirely for long periods. Many other species require certain definite periods of time in which to develop and it may be years after one appearance before you again see them. So too, at certain times, you will find it easier to secure some forms of insect life than others. Thus, in the early spring, butterflies and moths are scarce, but flies, wasps, bees, and many beetles are very common. Later on these will become hard to find and the host of butterflies and moths will make their appearance, while still later in the autumn an entirely new array of insect-forms will supplant the midsummer species.

There are many methods of collecting insects. You may capture them in their native haunts by various methods; you may secure the larvæ and raise them to maturity in confinement, or you may

breed the specimens and preserve all their various stages.

The best way is to combine all the various methods as some may be adapted to one group or species and not to another. As a rule, flies, bees, wasps, beetles, etc., are easiest to collect in their adult form and in their native haunts, while many moths and butterflies are easier to obtain by rearing them from the caterpillars, cocoons, or pupæ. But in each and every case there are certain species which it is almost impossible to rear, while others are seldom or ever secured unless they *are* raised in confinement.

Whatever branch of insect-life you decide to collect you will require practically the same appliances and tools and these should be on hand and ready for use before you commence to collect at all.

For collecting your specimens you will require a good net, a trowel, a strong knife, a pair of fine forceps, some empty tin boxes, a tin pail or a tin box with perforated top, a few small bottles of alcohol or formaldehyde solution, a bottle of benzine or gasolene, cyanide bottles and a quantity of rather stiff, smooth paper.

The form and material of the net will depend

mainly upon the class of insects you decide to collect. For butterflies, moths, flies, bees, and similar flying things a net of muslin, bobbinet, or even strong mosquito-netting will answer, whereas if you are to confine yourself to beetles, bugs, grasshoppers, and other creatures which live in brush, grass and among plants you should make the net of stout cheesecloth or cotton drill.

The exact form of the net is of no great importance, but a conical shape is preferable for butterfly collecting, while a square-bottomed shape is better for securing the smaller insects among plant growths (Fig. 1). These nets may be purchased ready-made, but you can make them yourself just as well, or you can get your mother or sister or the seamstress to make them. The size is an important matter, for a net which is too small is almost worthless and one too large is a nuisance. The best size is about ten inches in diameter and eighteen inches deep. The seams should be neat and smooth and around the open end there should be a hem of heavier cloth, or of the same cloth doubled over. The ring or hoop may be of iron or brass, but if iron is used it should be tinned or galvanized to prevent it from rusting. Brass rod or heavy galvan-

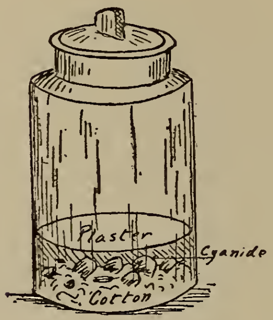


FIG. 4

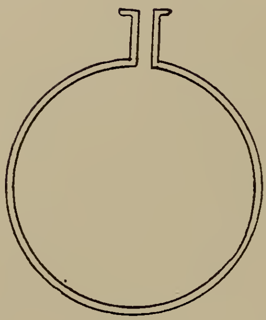


FIG. 2

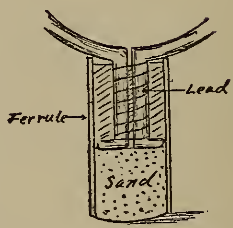


FIG. 3

FIG. 1

FIG. 1. Forms of insect nets. FIG. 2. How the hoop is made. FIG. 3. How the hoop is fastened in the ferrule. FIG. 4. Details of the cyanide bottle

ized telegraph wire will do very well for the thin butterfly net, but for the stouter net a stiff, strong, iron or steel hoop must be made. The wire should be bent into the form shown in (Fig. 2), with the two ends bound together with fine wire. A brass or iron ferrule should then be half-filled with dry sand, the ends of the hoop inserted in the ferrule and melted lead or solder should be poured in around it (Fig. 3). As soon as the metal hardens the net may be fastened to the hoop, a handle fitted to the ferrule, and the net will be ready for use.

The cyanide bottles may be purchased already prepared and this is the safest and best method of obtaining them, for cyanide of potassium is a deadly poison and is dangerous to have about or to handle. After the bottles are once prepared there is no danger, however, unless you break a bottle or are criminally careless and sniff at the contents. If you live in a place where cyanide bottles cannot be bought ready to use you can easily make them, but you should be very careful to buy only enough cyanide for the purpose and to use every speck of it in the bottles. A strong, wide-mouthed bottle is the best form and in this a thin layer of cotton should be placed. Scatter about an ounce of

cyanide over this cotton (using the lump form), place a little more cotton over the cyanide and then pour some plaster-of-Paris and water (mixed as directed for making molds) over the cotton for a depth of at least half an inch (Fig. 4). As soon as the plaster has hardened the bottle is ready for use, but it should be kept tightly corked at all times when not in use for the fumes are exceedingly poisonous and the cyanide will rapidly lose its strength if the bottle is left open.

Insects dropped into a cyanide bottle are killed painlessly and almost instantly and there is no better or more humane method of killing such things as beetles, bugs, flies, bees, wasps, grasshoppers and similar insects. Moths and butterflies should not, however, be placed in the bottles, for they will often be rubbed or injured and it is difficult to remove them without ruining them as specimens. For killing moths and butterflies, benzine or gasolene should be used and if the collector is very young, or if your parents consider cyanide bottles too dangerous, you may use gasolene or benzine for flies, wasps, and similar things and drop beetles and other hard-shelled insects into bottles of strong (50 per-cent.) alcohol or fairly strong formaldehyde solu-

tion. If the insects are left too long in these solutions they will become hard and brittle and will lose their colors, but if removed very soon and mounted they will not fade or be otherwise injured. When collecting beetles, and many other insects, as well as cocoons or pupæ, the small tin boxes are very useful and if you can obtain an assortment of various sizes, so that one fits within another when not in use, you will save a lot of space and trouble when carrying them about. For carrying live larvæ, or other living insects, a roomy box with perforated cover is used, or if preferred you may use a wide-mouthed jar with mosquito-netting tied over the opening. The pieces of smooth paper may seem very unimportant, but in reality they are essential to the collector of moths and butterflies. The papers should be of assorted sizes and should be folded and creased as shown in Fig. 5. They can be easily carried, either in a stout manilla envelope, in a blank book, or in boxes and take up little space. Practically the only satisfactory method of carrying butterflies and moths is in these folded papers and you should always have plenty of them on hand. To use the papers the specimen is placed within, as shown in Fig. 6, and the edges folded

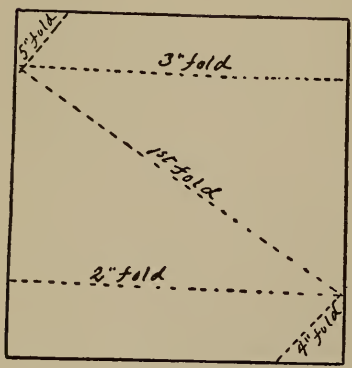


FIG. 5

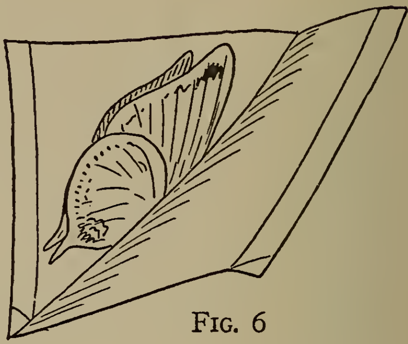


FIG. 6

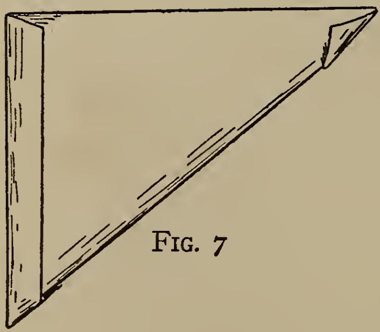


FIG. 7

FIG. 8

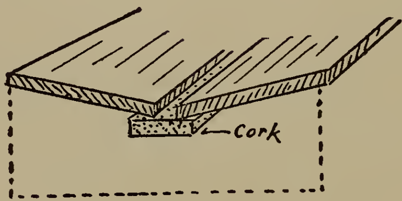


FIG. 9

FIG. 5. Insect paper showing where it is to be folded. FIG. 6. Insect placed in paper ready to fold. FIG. 7. Insect in folded paper. FIG. 8. End piece of spreading board. FIG. 9. How the cork is fastened to spreading board

down as in Fig. 7, and thus enclosed the insect may be quite carelessly handled and a large number of the papers, containing specimens, may be packed in a very small space. The best way of carrying them is to place them one on top of another in boxes and to prevent them shaking about pack a little soft cotton over them. As the box fills up the cotton may be removed gradually and when the box is completely filled with specimens the cotton may be taken out entirely and placed with the empty papers until required for another box. For preparing and preserving your insect specimens you will require boxes, cases, or cabinets, mounting and spreading boards, insect pins, a pair of fine scissors, forceps, needles, and a supply of Bristol board or old visiting cards. Insect pins *must* be purchased from dealers for ordinary pins will *not* answer for this purpose. The needles should be inserted in small wooden handles with the points projecting and the mounting-boards may be either purchased ready-made or they may be made from odds and ends which you can find around the house. They consist merely of two smooth boards fastened close together to end pieces formed as in Fig. 8, and with

a strip of cork along the bottom over the crevice between the boards as in Fig. 9.

If you cannot obtain cork in strips you may use sections cut from old bottle-corks or even corrugated pasteboard, but the sheet cork is far better and is very cheap.

You should have several of these boards of vari-

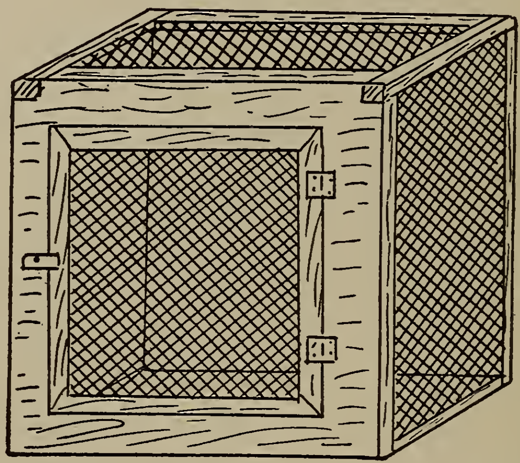


FIG. 10. A caterpillar breeding cage

ous widths on hand, the largest being a trifle wider than the width across the wings of the largest insects and the smallest an inch or two across and with a very narrow opening between the boards. The common manicurist's, or cuticle, scissors will serve very well, but any fine scissors will do for these instruments. There should be two pairs of

forceps—one straight and one curved—and a small, slender-nosed pair of pliers will also prove useful. The old cards, or the Bristol board, is useful and necessary and is almost always available in any household. For the cases you may use regular insect cabinets, or cases of drawers in which thread is sold. Any tight, glass-covered box or drawer will answer, but the bottom should always be provided with cork in which to stick the pins on which the insects are mounted. Sheet cork is the best material, but sections of bottle-corks, corrugated pasteboard or even strips or sections of corn-stalk pith will do very well at a pinch and I have known collectors who preferred thin sections cut from poplar or cotton-wood trees. The very best kind of cases are the Riker insect mounts. These are pasteboard boxes with glass covers and filled with many thin layers of smooth, soft cotton. The insect to be preserved is placed (after being mounted and dried) upon the cotton and the cover is then pressed firmly into place and secured by binding the edges with gummed paper. These are moth-proof, neat, and occupy little space and by their use you are able to examine each individual insect whenever you wish. Riker mounts are not expensive and

any young collector may easily make such mounts from old dry-plate or other boxes and old glass negatives or window-glass.

In any case you must be sure to place some insecticide in the case or box with the specimens, for even if the case itself is moth-proof there may be eggs or young larvæ of museum pests in the specimens and these will soon increase in number and work havoc with your collections.

Naphthalene flakes, camphor, bisulphide of carbon, and solid formaldehyde are all excellent for this purpose but the cheapest and most convenient is the naphthalene. In addition to these things you must have plenty of labels on hand, for an insect improperly or carelessly labeled, or without a label, is of little value in a collection. The smallest insects may be merely numbered and the names, localities, etc., may be written in a book or catalogue with corresponding numbers. Where insects are kept in individual cases or mounts the label may be placed on the side or bottom of the container or numbers only may be used, as for small things. Most insects should be provided with a neat, small label on the pin which supports the specimen and in every case a number as well as the label should be

provided and the specimens should be carefully catalogued by number, as labels will sometimes become illegible or destroyed.

While on the subject of labeling let me caution all collectors to write their labels in waterproof or indelible ink (Higgin's waterproof ink is as good as any), and *never* in pencil. Many a rare or valuable specimen has been lost or rendered of no scientific value through inattention to such matters, for pencil will rub out, ordinary inks will fade and a once carefully made label may become merely a blank or discolored scrap of paper after the lapse of a few years.

If you expect to rear insects from the larvæ or pupæ you will also need one or more breeding cages. These may be any tight wooden boxes with netting or muslin doors or covers and even flower pots with muslin or netting tied over them will often serve every purpose. For convenience and the best results, however, you will find it worth while to make neat breeding cages with wire-netting (such as is used for window screens) on at least two sides or on the top and one side. There should also be a good sized hinged door (Fig. 10). If you expect to collect caterpillars or grubs as specimens you

must have a caterpillar oven, although if you prefer, you may make wax casts of the larvæ or may

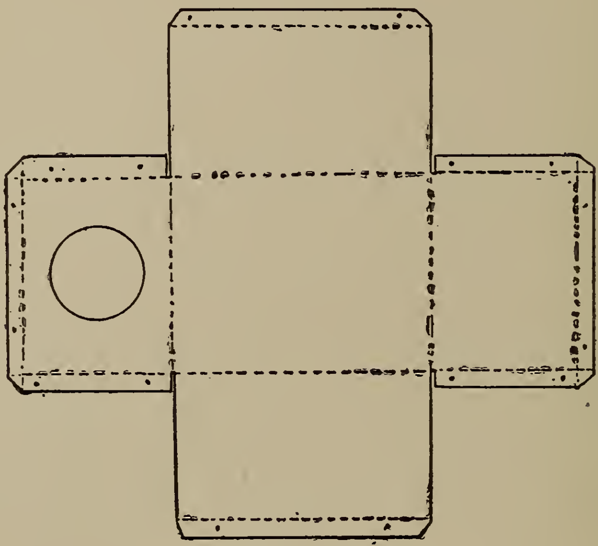


FIG. 11

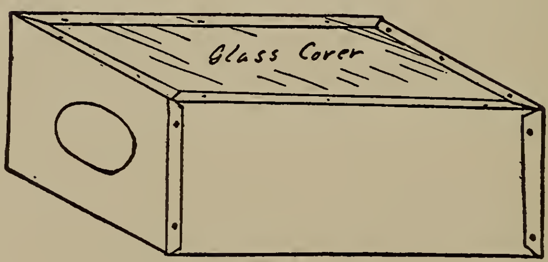


FIG. 12

FIG. 11. Form of tin for making drying oven. FIG. 12. The oven complete

preserve them in alcohol or formaldehyde. Good photographs and colored sketches of the larvæ are also valuable and interesting and in many ways it

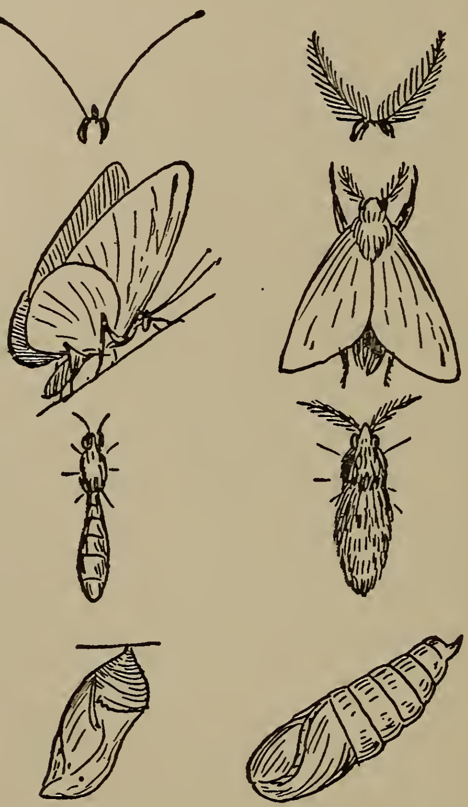
is better and easier to make your caterpillar collection in the shape of pictures than to collect and preserve the real specimens. The caterpillar-oven consists of a tin box made of a sheet of tin or thin iron in one piece. The sheet of tin should be cut in the form shown in Fig. 11 and should then be bent in the places and in the manner indicated by the dotted lines. These bent edges are then riveted in position to form the box (Fig. 12) over which a sheet of clear glass is placed.

Having all the appliances ready to begin collecting we may consider the actual work of capturing, preserving, and preparing the specimens and as butterflies and moths are the most attractive of insects and are the greatest favorites with boy collectors we will commence with this group.

Moths and Butterflies

Moths and butterflies are very frequently confused and while there is little resemblance between typical forms of either group, yet certain species are difficult to distinguish. There are really many differences between moths and butterflies and before you commence to collect them you should try to learn these distinctions. Most butterflies are day-

fliers and rest during the night, whereas most moths are night-fliers and rest during the day. Butterflies, as a rule, have rather thin, delicate wings,



How to distinguish a moth from a butterfly. Characteristics of moth at right and of butterflies at left

slender bodies and thread-like antennæ with enlarged tips, while most moths have rather thick, strong wings, stout, fuzzy bodies and feather-like antennæ. The majority of butterflies, when at

rest, hold their wings side by side vertically above their bodies while moths, when at rest, fold them longitudinally, or like a little roof, over their backs. Moths ordinarily obtain the nectar from flowers by hovering before the blossoms, while butterflies usually alight upon the flowers and obtain their food while at rest. In the caterpillar and pupa state there are also many differences to be noted. Most moths enclose their pupæ in a silken cocoon or bury it in the earth, while butterflies suspend a naked pupa or chrysalis from some convenient object. The caterpillars of both moths and butterflies vary so in form, structure, and color that it is often difficult to tell which is which, but there are certain forms which are distinctive.

Thus naked caterpillars bearing a horn or eye-like spot at the rear end are typical of moths and do not occur among the butterflies whereas naked caterpillars which project ill-smelling, forked horns from near the head, when disturbed, are typical of certain butterflies. Larvæ bearing stiff, irritating, branched spines occur both among moths and butterflies but densely haired or very woolly caterpillars are practically always the larvæ of moths.

Even the characters of the adult insects already

mentioned are not always typical of either moths or butterflies. Thus certain species of moths fly about in daytime and rest at night, but I do not know of any species of butterfly that flies at night and rests during the day. Hence any night-flying insects of these groups must be considered as a moth. Many moths have slender antennæ, but I do not think any butterfly is known with feathered or fern-like antennæ and therefore you may be reasonably certain that any insect of these two groups which has feathered antennæ is a moth. Many butterflies rest occasionally with their wings horizontally folded, but moths seldom or never raise their wings vertically while at rest. Moreover, among foreign butterflies and moths there are species which imitate certain individuals of the other group and in many of these cases even an expert entomologist may be puzzled to determine which is the moth and which the butterfly. Among our native species it is seldom difficult to distinguish moths from butterflies however, and by noting the form of body, the style of antennæ, and the manner in which the wings are held you can almost always tell whether the specimen is a butterfly or a moth.

Although we generally associate butterflies with

sunny open fields, green meadows, and summer flowers, yet many of them live in dark woods. Others spend most of their lives in damp, dank bogs and swamps; others seldom rise more than a few inches from the earth; while still others flit about among the tree-tops many feet above the ground and rarely ever descend.

To secure a representative collection of butterflies you must hunt in all manner of places, for the casual observer sees but a small portion of these insects. It may seem at first a very easy matter to capture a butterfly as it flits lazily from flower to flower or sails through the summer air. But to catch these insects and secure them without injury is not always as easy as it seems. Because a boy can rush madly after a butterfly, bang it with his cap, and secure the poor, mutilated creature, does not prove that it is a simple matter to catch a perfect specimen without breaking or hurting it. Quite a little practice is required before you can be sure of securing your coveted specimen every time, and your time will be well spent if you practice on some common injurious species such as the white and pale yellow "cabbage butterflies" which are serious pests to gardeners.

Butterflies seem to delight in teasing the insect collector and flit away just as the net descends, only to alight on some other object a short distance away where they wait patiently until once more the net sweeps down and again they escape, and continue to repeat the performance over and over again until one is hot, tired, and out of patience, whereupon the evasive insect sails calmly away out of sight.

To succeed in catching butterflies with the net you should approach the insect slowly and cautiously; never rush or run toward it, for a sudden motion or a slight jar or noise will often frighten it. Do not try to catch the insect until you are sure it is within reach of the net for if you miss, the butterfly may fly far away and out of sight. In using the net make a quick, sure sweep sideways and with a twist of the wrist turn the net over as soon as the insect is captured, so that the bag folds over and prevents the butterfly from escaping. Never try to bring a net down over a butterfly if it is possible to use the side sweep. If this is done the plant or other object upon which the insect rests will usually tear your net and the butterfly will escape through the rent or from beneath the edge

of the net. Of course there are times when it is necessary to bring the net straight down, as for instance when a butterfly is resting on the earth, on a tree trunk, on a stone, or on a spot where he is in a depression; but even in such situations an expert will usually manage to capture his specimen with a side stroke. As soon as the insect is caught and the net folded as described, gather the bag up carefully and hold the folds tightly enough to prevent the captive from fluttering. Grasp the butterfly between the thumb and fingers from the outside of the net and drop a little benzine or gasolene upon it. The hold on the insect may then be released, the net unfolded, and the insect carefully removed. Do not try to lift a butterfly or moth by the wings, and if possible handle it with forceps and not with your fingers. The least touch upon the wings will rub off the delicate scales and injure the specimen; the best method is to use the forceps and grasp only the body. Very often a captured butterfly in a net may have one or both pairs of wings spread out and in such cases it is a good plan to drop the benzine upon it before attempting to grasp it. As soon as the insect is dead and removed from the net place it in one of the prepared papers—being

sure that the wings are folded in their proper position, vertically over the back—crease down the edges of the paper and place it in the box or container as already directed.

When you reach home you should proceed to mount the specimens while they are still fresh and flexible. Much better results can be obtained in this way, but if for any reason you cannot attend to them at once they may be left in their papers until it is convenient to mount them.

Then the papers should be placed (without opening) in a box partly filled with damp sawdust or sand where they should be left overnight. The next day the papers should be carefully opened and the insects should be gently turned over and left exposed in the box until they are thoroughly softened and flexible. It is a good plan to dampen the sand or sawdust with a little formaldehyde solution or carbolic acid, as otherwise the specimens may mildew or mold.

After the insects are softened they may be handled and mounted exactly as if they were freshly killed. First grasp the butterfly or moth at the thorax between the thumb and fingers—being careful to keep the wings side by side and vertically

above the body (Fig. 13)—and with the other hand press an insect-pin down through the thorax—the part of the body just back of the head—using care to run the pin from top to bottom in line with the front edges of the wings and in the center of the thorax. Run the pin straight, for if it enters at an angle the body will be askew on the pin and a good,

FIG. 13

FIG. 14

FIG. 13. How to grasp a butterfly for pinning. FIG. 14. How to pin the butterfly

well-mounted specimen cannot be obtained. Push the pin through the thorax until a little more than half its length projects below the body (Fig. 14) and then pin the insect in a groove of a mounting-board with the body longitudinally in the crack and with the upper side of the body just level with the two side pieces of the board (Fig. 15). In select-

ing the pin use one suited to the size of the insect; a pin that is too fine is a nuisance and will not support an insect that is large or heavy, and, on the other hand, a pin that is too large may break or injure the specimen and will look coarse and ugly. Use a mounting board which has a width greater than the spread of the insect's wings and with an opening between the boards which is only a trifle wider than the insect's body.

When placing the first specimen on a board set it near one end, or at the top (Fig. 16), so that other insects may be mounted without injuring or disturbing the first one. When the specimen is in position select one of the needles in a wooden handle and gently press one pair of wings down to the board. Use care in doing this and do not attempt to pierce the wings with the needle, but press it firmly sideways against the thicker edges or ribs of the wings close to the body. With very fine pins, inserted through the thick ribs of the wings or very close to them, pin the wing to the board and repeat the operation on the opposite side. By means of your needle points and pins arrange the wings in a natural position and use great care to see that both pairs of wings are equally spread and

that both are in line across the board. In order to make this easier it is a good plan to have lines ruled

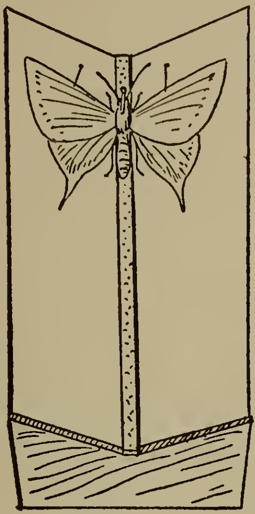


Fig. 16

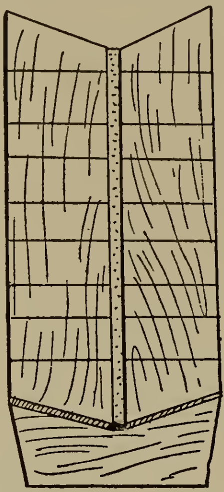


Fig. 17

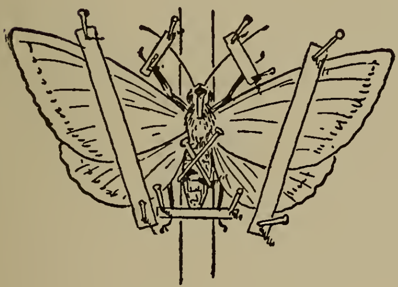


Fig. 18

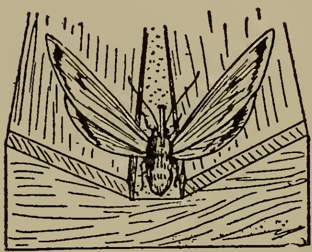


Fig. 15

Fig. 15. How a butterfly should be pinned on spreading board. Fig. 16. Place the first specimen at one end of the board. Fig. 17. It is easier to spread the specimens evenly if the board is ruled. Fig. 18. Secure the wings and legs in position by strips of paper pinned in place

across the mounting boards at frequent intervals (Fig. 17).

When the wings are arranged satisfactorily take some narrow strips of card, lay them across the wings, and pin them firmly to the board with stout, common pins inserted through the strips beyond the edges of the wings (Fig. 18). Remove the fine pins, which held the wings in position, and with your needles and forceps lift up and arrange the fore legs and antennæ and secure them in position by tiny strips of paper as shown in the illustration. If the body is out of true, or twists to either side, secure it by pins placed diagonally across it as in the cut and then set the board with the insects in a safe place to dry. Select a cool, dry spot, free from dust, insects, or draughts of wind, such as a shelf in a closet or a large tight case, but *never* in a small box, in a drawer, or in bright sunlight. Many of the butterflies and moths have very different colors or patterns upon the upper and lower surfaces of their wings and when such is the case it will add a great deal to the interest of the collection to have two specimens of the species—one mounted upside down the other right side up. Still other species have bright-colored lower wings and dull colored upper wings which conceal the others when the insect is at rest. In this case a specimen should be

mounted with wings fully spread to show both pairs and another specimen should be prepared with the wings folded as in life (Fig. 19). After the insects are thoroughly dry remove the pins and strips of card which hold the wings, body and legs, etc., in place, and very carefully remove the specimen from the mounting card by means of the pin through its body. If the specimen is to be kept in a case or drawer the pin should be thrust through its proper label (a temporary label having served while the insect was drying) and the specimen pinned firmly to the bottom of the receptacle. If it is to be mounted in a Riker mount the lower side of the pin must be carefully cut off just beneath the body, the insect placed in position on the cotton and the upper portion of the pin snipped off with a pair of small cutting-pliers. Another method is to mount the insect on the mounting board as directed and after the wings, legs, antennæ etc., are arranged and secured, withdraw the pin from the body very carefully by holding the tips of the forceps on either side of the pin against the thorax while pulling upward gently on the pin. Never try to remove a pin from an insect after it is thoroughly dry—once in a great while it may be accom-

plished in safety, but nine times out of ten you'll ruin the specimen and break it to pieces.

You will be able to obtain a large proportion of your butterflies with the net, as they rest on flowers, hover by the sides of puddles, or flock about piles of decaying fruit or carrion, but you will find other methods must be employed to secure specimens of moths. Some species, such as the clear-wing or "humming-bird" hawk moths fly about in the brightest sunshine and hover before flowers like bumble bees or humming-birds and such species may be captured with the net. Other species, such as the larger sphinx, or hawk, moths hover before flowers in the evening and suck the nectar by means of their long, flexible tongues which are kept coiled beneath the head, like a spiral watch-spring. By using a flash light or bull's-eye lantern or by strolling among the flowers in the dusk of early evening, or on moonlight nights, many of these may also be captured with a net. By far the greater number of moths must be obtained by trapping, jacking, or sugaring, however. All moths, as well as many other insects, are attracted by lights, and a moth-trap is merely a box of wood or netting with a funnel-like opening and with a lantern placed at

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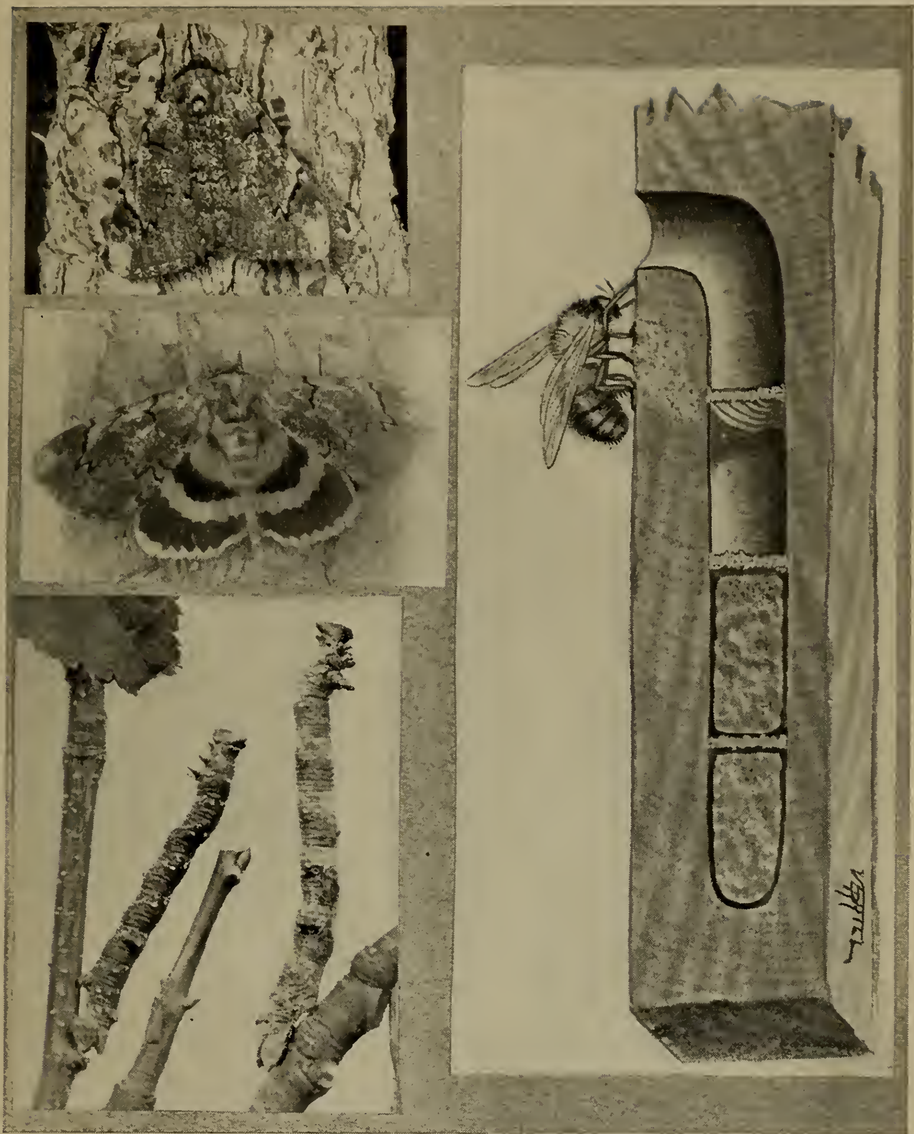


28

Methods of Mounting Moths, Bee and Caterpillars
(See Chapter V)

A Moth May Be Mounted on Its Cocoon. This Specimen Is the Prometheus
(See Chapter V)

one end behind a screen of glass or netting (Fig. 20).

Even a plain lantern will often attract many moths, especially if set in a garden among flower beds, in the woods, or in an orchard. If an open lantern is used the moths may be captured with a net as they flit about the light, while those in the trap may be killed by dropping a little benzine upon them or squirting it on them with a small syringe. Before using the benzine the light should be removed from the trap however, unless an electric light is used.

Sometimes a great number of moths may be secured by placing a bright light behind a sheet or piece of white cloth. As the moths light upon the white, illuminated surface, they may be caught with a small net or may be killed by squirting benzine upon them. Moths may also be stunned and rendered unconscious by striking them sharply upon the thorax with a piece of flexible cardboard or stiff paper. They may then be killed with benzine and in many cases this is the best method to follow. It is particularly useful in catching the handsome "underwing" or Catocala moths and the large sphinx-moths which rest during the day upon

stones, fences, or tree-trunks. The upper wings of these moths so closely resemble the objects upon which they rest that they are almost indistinguishable, but as soon as they fly their bright-colored lower wings of red or yellow are very prominent. To successfully hunt these moths requires keen eyes and not a little skill, for they'll lead you a merry game of hide-and-seek through the woods as they flash into view at your approach, only to disappear as if by magic when they alight upon another tree. A great many night-flying insects and many moths may also be obtained by "sugaring." If you "sugar" for beetles and other small insects the sugar preparation may be placed in bottles or jars and the creatures attracted will drop into the mixture and you can secure them at your leisure; but for moths another method must be followed. In this case the mixture should be painted or smeared upon the trunks of trees, upon fences, stones, or other objects. The mixture used in "sugaring" consists of sugar, molasses, vinegar, water, and stale beer. Coat a number of trees or other objects with the mixture and with net and lantern visit them every few minutes. You will find many rare and beautiful specimens attracted to the sweet

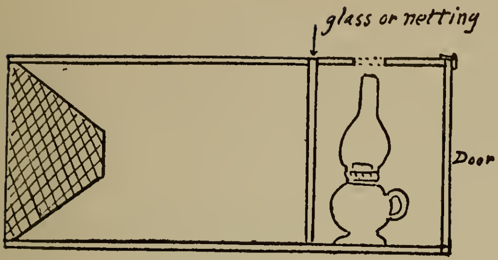


FIG. 20

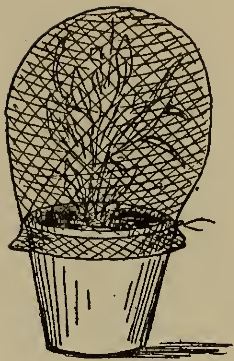


FIG. 21

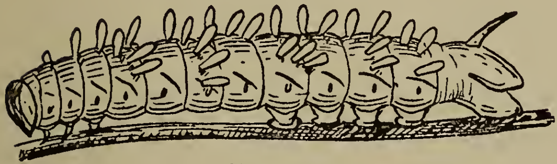


FIG. 22

FIG. 23

FIG. 25

FIG. 26

FIG. 20. Moth trap. FIG. 21. A flower pot breeding cage. FIG. 22. Larva infested by ichneumon cocoons. FIG. 23. How to cut a caterpillar for drying. FIG. 25. Beetle mounted with wings closed. FIG. 26. Beetle mounted with spread wings

compound and so intent upon eating it that they may be readily captured. Sugaring in this way often attracts many butterflies during the daytime and every insect collector should make frequent use of this method of obtaining specimens.

The powerful electric lights of cities and towns often attract great numbers of night-flying insects and the young collector may often obtain rare and fine specimens by going the rounds of the lights with a cyanide bottle, an insect net, and some benzine. In large cities there are few insects about the lights, but in parks, in the suburbs, and in small towns and country villages vast numbers of insects are attracted to the lights. Of course a great many of these find their way into the globes and are broken, burned, and ruined, but many of them flit about until tired, when they rest themselves upon near-by trees, fences, or posts, or else become dazzled or stunned and drop to the street or sidewalk beneath the lights where they may be easily caught.

Although you can manage to obtain a very good collection of moths and butterflies by the various methods described, yet certain species are seldom obtainable except by rearing them from the larvæ.

At Top, a Well Mounted Moth. At Bottom, Ichneumon Fly Emerging from Chrysalis

(*See Chapter V*)

Far more perfect specimens may be secured by rearing butterflies and moths than by catching them fully grown, you will learn much more about their lives and habits in this way than by hunting the adult insects and in addition it's very interesting to raise larvæ or pupæ and watch them transform to moths and butterflies.

Whenever a caterpillar is found it should be placed in the box with the perforated top, with a few leaves of the plant on which it was feeding and you should take care to note the kind of plant on which it was found. Each species of larva has a certain food plant and while many kinds will devour a great variety of plants, yet others will eat but a single species and will starve to death unless the proper plant is provided for them. When you reach home the leaves and twigs should be placed in a bottle, or jar, of water with cotton or paper stuffed into the mouth around the stems so that the larvæ will not fall into the water and the whole should then be placed in the breeding cage with the larvæ. A number of kinds of caterpillars may be kept in the same cage, but they will do better if not crowded and it is a good plan to keep each species by itself.

Many species of larvæ enter the earth to transform to a chrysalis and the breeding cage should always be provided with a layer of earth several inches in depth, or with a small box or tin filled with earth. Quite often a flower-pot filled with earth and with a growing plant will make an excellent breeding-cage for a single caterpillar if some muslin or mosquito-netting is tied over it as in Fig. 21.

Leaves or plants must be changed each day and fresh ones given to the larvæ, for caterpillars will not attain full size and be healthy if they are compelled to feed upon wilted or dried leaves. Many of them are very ravenous and devour an immense amount of green food, but no matter how much they eat you must provide enough so there is always some left over—you cannot overfeed a caterpillar. Keep the cages clean and neat and never handle or touch the larvæ if it can be avoided and as soon as they transform to pupæ or cocoons leave them undisturbed until they emerge as moths or butterflies. Some species make their pupæ and emerge as adult insects the same season, but the majority remain over winter in the pupæ state. These will be far healthier if kept out of doors in a sheltered spot or

in a dry cellar, for it will not injure them to freeze solid. Earth which contains pupæ should, however, be given a covering of dead leaves, straw, or litter, and the boxes or tins containing them should be protected from rain, for if the earth becomes too damp or water-soaked the pupæ will mold and decay.

Oftentimes a caterpillar will develop queer, white protuberances or little cottony objects upon its skin. When this occurs it is just as well to kill the poor creature at once, by dropping it into alcohol or formaldehyde or a cyanide bottle. If you don't do this the larva will die a slow and lingering death, for the white objects are the cocoons of small flies, known as ichneumon flies, which lay their eggs upon, or just under, the surface of the skin of the caterpillar. The fly larvæ hatch out within the body of their victim and actually eat him alive and when fully grown form the white cocoons upon the doomed caterpillar's skin (Fig. 22). Although the larva may not appear to be injured or greatly disturbed by these parasites yet it will surely die and even if it lives long enough to form a pupa or cocoon no moth or butterfly will ever emerge therefrom.

Another class of ichneumons do not make them-

selves known until the pupa or cocoon of the caterpillar is made. The larvæ of these flies live within the body of the caterpillar and do not transform to pupæ until the caterpillar victim has itself made its chrysalis. Then, while the caterpillar dies, the fly pupæ live on and eventually flies issue from the chrysalis or cocoon instead of a butterfly or moth—much to the surprise of the collector. These parasitic flies are very useful to man and do a splendid service in keeping injurious insects in check. For this reason you will confer a real benefit upon the agriculturists by turning loose any ichneumon flies which hatch from your pupæ or cocoons, as well as any larvæ which are affected by the flies, but it seems a rather inhuman and cruel thing to do and personally I can never bring myself to let parasite-infested caterpillars go on suffering, but invariably kill them; even though I realize I am thus aiding and abetting the increase of injurious larvæ.

Of course if you collect flies and other insects these ichneumon flies should also be collected and preserved, and even a moth or butterfly collection will be more interesting and scientifically valuable if the various parasites of the larvæ are preserved

and exhibited with the species they infest. All insect parasites are of great importance and the study of their lives and habits has saved millions of dollars' worth of grain and fruit, and there is a small army of entomological experts continually scouring all parts of the world in search of parasites which will prey upon such insect-pests as the gipsy and brown-tailed moths, boll-worms, army-worms, various scale-insects, and other injurious species.

The larvæ and pupæ of moths and butterflies are just as interesting and important as the adult insects and many of them are very beautiful in color or are so striking and peculiar in markings or form that they are well worth preserving. The ideal way of collecting caterpillars is to photograph them and either color the photographs by hand or make water-color sketches to accompany the photographs. In this way you can rear the larva, obtain the moth or butterfly and also show the appearance of the caterpillar. Oftentimes this is a great advantage as you may never find more than one or two specimens of some rare larva. Another method is to preserve the caterpillars in alcohol or formaldehyde and if this is done you should make colored sketches also, for the colors of the larvæ will entirely dis-

appear after a short immersion in the solution. Still another method is to make plaster-molds and wax casts and for naked, smooth-skinned larvæ this is a very satisfactory method. It is, however, impossible to make casts of the hairy, woolly, or spiny species and advanced collectors usually preserve their larvæ by blowing and drying them. This is not difficult and if well done the larvæ will retain their natural colors and forms to perfection.

It was for this purpose that the tin caterpillar oven was provided and the method of preserving the larvæ by this process is as follows:

First kill the larva by dropping it into a cyanide bottle. Then with a pair of very fine scissors make an incision in the rear end of the caterpillar as shown in Fig. 23. Place the caterpillar on a sheet of blotting paper and with another sheet press firmly upon the body—working from the head backwards—until all the internal organs are pushed out through the cut. Then spread a layer of dry sand, about half an inch deep, over the bottom of the tin oven, set the oven on a small stove, lamp, or electric heater and place the glass cover in position. While the oven is warming up insert a straw in the incision in the larva's body, secure it in place with a

very fine insect pin, and blow gently through the straw until the skin of the caterpillar fills up plump and naturally. While still blowing place the caterpillar in the hole in the end of the oven and while turning it about continue to keep the skin inflated until the skin is dry and stiff and retains its plump form. The process may be watched through the glass top to the oven and you should use care not to get the oven too hot and scorch or brown the larva. Your first attempts should be confined to fairly large, smooth-skinned larvæ, for these are much easier to prepare than those with hair or spines, but as soon as you once acquire the knack of drying them you will find it an easy matter to accomplish. No doubt the first few larvæ you dry will be straight, rigid, and far from natural in form, but this will soon be overcome and you will learn just how to bend or move them until you can dry the larvæ in any position you wish. Some collectors obtain wonderfully lifelike results by filling the dried skins with melted paraffin, which may be injected by means of a small syringe or by drawing the melted wax into a small tube or straw and blowing it into the skin through the opening between the hind legs. Many larvæ will turn dark or will fade in drying

and in such cases the finished specimens may be touched up with oil-colors and a fine brush. As soon as the skin is stiff and dry remove it from the oven, turn it about once or twice until cool and place it on a sheet of soft cloth or on cotton until ready to mount. Prepared caterpillars may be placed in the Riker mounts with the adult insects, or they may be pinned in cases or boxes with pins thrust through the rear end of the bodies. The most attractive and interesting way of mounting them is to arrange them in their natural attitudes upon their food-plants, either in cases, in Riker mounts by themselves, or in combination with their adult forms of butterflies or moths. A great many of our caterpillars have marvelous habits of imitating surrounding objects and by studying these and imitating them with the preserved larvæ you can produce very interesting and striking groups. Among such are the common "Twig-caterpillars" which counterfeit twigs while at rest (Fig. 24). Such specimens never fail to arouse interest and admiration in those who view the collections.

Pupæ and cocoons should also be preserved, but to prepare these is very simple. Cocoons may be kept until the adult insects emerge and the empty

cocoons may then be placed in the collection, but pupæ must be killed by being soaked in alcohol or formaldehyde and afterwards dried or else they may be kept permanently in the solutions, which is a far less satisfactory method. Many of our common larvæ go through a number of stages before they transform to pupæ and they often differ so greatly during these several transformations that you can scarcely believe they are one and the same species. In such cases you should strive to preserve or photograph all the distinct stages of the larvæ. All these little details add greatly to the value and completeness of the insect collections and you should try to secure specimens of each species in as many of its stages of growth as possible and at the same time illustrate its habits, food plants, and mode of life by arranging the specimens of larvæ, pupæ adults, etc., in groups in their natural attitudes and among their natural surroundings.

Beetles, Bees, and Other Insects

Beetles are among the most numerous of all insects and are found nearly everywhere. Many species live in dead or decaying wood, others are ground-loving species and are found beneath stones,

logs, etc. Others are always found on flowers, others on plants, trees, or leaves, and others on decaying carrion or animal matter.

Many beetles are injurious and do an immense amount of damage to crops, grain, foodstuffs, fabrics, and timber, while others are equally useful and prey upon other injurious insects.

The larval forms of beetles are known as grubs and the only way to preserve them is to keep them in alcohol or formaldehyde or else make wax casts, which is seldom worth while.

Beetles are very easy to collect and may be killed by dropping them into cynanide bottles or into alcohol or formaline. They may be mounted by pinning through one of the wing-covers (Fig. 25) and then spreading the legs and antennæ or they may be pinned through the thorax and prepared with wings spread as in Fig. 26. As a rule the former method is preferable, for the wings of beetles are seldom ornamental or attractive and the specimens appear far more life-like with the wings folded. Beetles may be kept in cases, drawers, or cabinets or in Riker or similar mounts, and those species which feed upon plants or have peculiar habits should be arranged to illustrate such matters.

Many fine beetle specimens may be obtained by sugaring, as already mentioned, and many others may be secured about electric lights. Another fine collecting ground for beetles is on the shores of lakes or on the seashore. Vast numbers of insects, flying over the water, become exhausted and drowned and their bodies are washed up on the beaches. Many of these are broken and ruined, but by looking over the trash and seaweed cast up by the waves you will find a great many very perfect and unusual specimens. Some species of beetles fly as readily and as rapidly in the daytime as other insects and for these you will have to use the insect net.

Some of these, such as the beautiful Tiger beetles, which are carnivorous and live upon hot, sandy spots, are very difficult to capture, while others, which hover about flowers or around plants, are easy to obtain. Many beetles are very fond of decaying fruit, or the sweetish sap from trees, and large numbers may sometimes be captured by setting out bait in the form of decayed vegetables, fruit, and similar things.

A great many beetles feed on the pollen and nectar of flowers and upon milkweed, roses, golden-

rod, and many other plants quite a number of beetles may usually be found. There are also many species which bore into both decayed or solid wood and the only way to secure specimens of some of these boring beetles is to dig them out of the wood or else rear them by carrying home the larvæ-infested wood and placing it in a cage or box.

By turning over stones or logs one may often find many interesting ground beetles, some of which are very beautiful in color.

Among our strangest beetles are the so-called "carrion-beetles" or "burying-beetles" (Fig. 27). These may be found by turning over dead birds or animals, or cow-dung, and while they live in such disagreeable places they are well worth collecting on account of their bright colors and remarkable habits. These insects dig away the earth beneath the decaying animal matter until they actually succeed in burying it, whereupon they deposit their eggs in the mass and thus provide a supply of food for their young larvæ.

Among the grass, weeds, plants, and brush of fields and pastures a vast number of insects live throughout the warmer months. You may wander for hours, or days, among such growths and never

suspect the teeming life which surrounds you, for aside from the crickets, grasshoppers, and an occasional moth or butterfly, the insect denizens of

FIG. 27. Carrion or burying beetles at work

these places are shy and retiring. The boy collector will find a wonderful number of specimens in such situations, and it is in this work that the

stout, square-ended beating-net is used. Walk through a field or pasture and swing the open net back and forth through the weeds and grass before you and after proceeding a few hundred feet stop and carefully examine the interior of the net. You will find a number of bits of grass, many leaves, some seeds and flowers and among these—and scurrying back and forth upon the inside of the net—a veritable army of insects. Among them will be representatives of nearly every group—grasshoppers, crickets, moths, flies, wasps, bees, bugs, beetles, caterpillars, ants, spiders, and probably a few small butterflies. No doubt there will be so many specimens that you cannot capture and kill all you want before some escape, but if you are seeking some special group or groups you can pay attention to these only and let the other things go. Another good plan is to fold the net over—after beating for a time—and then quickly empty the contents into a deep netting bag with a draw-string at the top. Then by drawing the opening tight you can shake and work the captives into a small space at the bottom and dip the bag and contents into gasolene. This will kill all the creatures and those which you do not want may be thrown away. This

may seem like wholesale destruction, but destruction of insect life is commendable, as the majority of the things killed are injurious to crops or forage.

Another method by which many small insects and ground beetles may be obtained is to spread a white cloth or sheet upon the ground, rake up leaves and earth in the woods and sift it through a sieve upon the sheet. Among the fine litter and bits of decaying wood and leaves you will usually find a large number of insects and a great many small land snails. Some species of beetles can be obtained only by such methods and the successful collector is he who resorts to all means and searches in all places for his specimens.

Wasps, bees, and hornets are very interesting insects and many of them have habits, life-histories, or peculiarities which are worthy of study. Bees, wasps, and hornets may be caught in nets or may be captured by sugaring, and many of the smaller species may be obtained by beating grass and weeds. Wasps, bees, and other winged insects should be killed by benzine, in cyanide bottles, or by immersion in alcohol or formaldehyde, and they should be mounted on mounting boards like butterflies or moths. The larvæ of bees, wasps, etc., must be

kept in alcohol or formaline if they are to be preserved, but they are usually of little interest. The nests or homes of these insects are, however, very interesting and should be preserved. Wasps' nests and hornets' nests may be kept without preparations, but it's a wise plan to dip them in gasolene or benzine in order to kill any eggs or grubs which might later emerge as full-grown hornets and make things lively. Many of the bees and wasps make very interesting homes in trees, fences, or wooden objects, and these should be collected and exhibited by cutting out a piece of wood containing the nest. The piece may then be cut or sawed so as to expose the interior and the adult insect may be mounted in a natural attitude upon it (Fig. 28). Flies are very numerous and many species are beautiful and curious and until one collects them it is hard to realize how interesting and variable these insects really are. They should be mounted in a similar manner to bees, wasps, etc., and grasshoppers, crickets, bugs, and other winged insects are treated in the same way. Finally, do not overlook the brooks, streams, and ponds in your search for insects. There are many species of water-beetles, water-bugs, water-flies, and even moths whose

larvæ live under water. Around the edges of bodies of water one often finds certain species of moths, butterflies, beetles, and other insects which are never seen in any other situations.

CHAPTER VI

FRESH WATER ANIMALS

IN the waters and upon the beds of lakes, ponds, brooks, and streams there are immense numbers of very interesting creatures. Of course we are all familiar with turtles, frogs, fish, and other forms of water life, and while many of these make interesting collections there are other things which are far less known and far more interesting and of greater educational value.

If you expect to collect frogs, turtles, reptiles, or fish you will find the best method is to make plaster or wax casts of the frogs, salamanders, and other soft bodied creatures, while the snakes and turtles may be skinned, stuffed, and mounted; but this is hard, mussy, and unpleasant work. Moreover, in order to make such collections you must destroy a great many harmless and really useful creatures, and the aim of the boy collector should be to protect and encourage all forms of life which are not really injurious or which are of such minor

importance that they can well be spared. Fortunately, a good collection of photographs of frogs, turtles, snakes, etc., is more satisfactory and attractive than a collection of the real objects and it's far more fun to obtain them.

Among the lower forms of water life you'll find an abundance of interesting things, many of which you never dreamed existed, and no one can find fault with you for collecting and preserving them.

For collecting specimens in fresh water you will need a few tools and appliances, but they are all easily made or inexpensive. You should have a dip-net of some sort and this may be either a fine-meshed minnow-net, or you can, if you prefer, make it yourself by sewing a piece of fish-net to a stout hoop made as directed for insect nets. Another important implement is a scoop, which may be made out of any old tin or iron dipper or saucepan by simply punching numerous holes in the bottom and bending it flat on one side as indicated in Fig. 1. This should be fastened to a long, strong handle, but any pole cut in the woods or beside the brook or pond will serve and the scoop may be wired, lashed, or nailed to it and the handle detached and thrown aside when you are through using the scoop, thus

saving the trouble of carrying a handle back and forth on your trips.

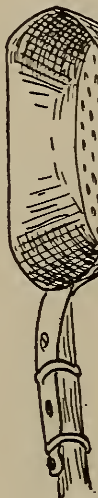


FIG. 1

FIG. 4

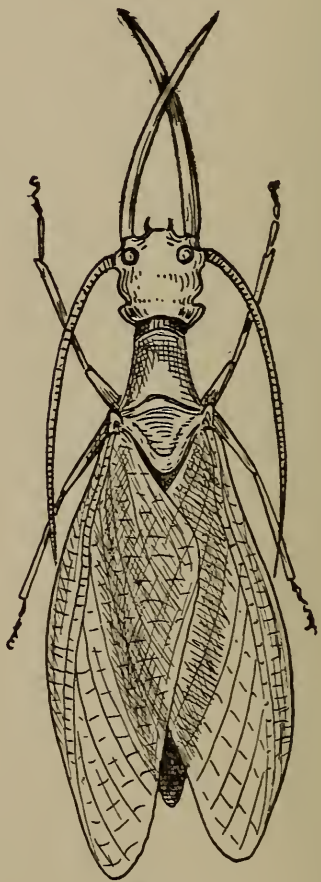


FIG. 3

FIG. 1. The saucepan scoop. FIG. 3. Horned corydalis.
FIG. 4. Giant water bug

An old iron rake is also useful and you should have a number of jars or bottles, some empty and

others filled with alcohol or formaline. The bottles may be carried in a basket, valise, or any other receptacle, and a common fish basket or "creel" is excellent. The only other tools you will need are a pair of forceps and, if possible, a pocket-lens or magnifying glass, a tin pail, and a small sieve.

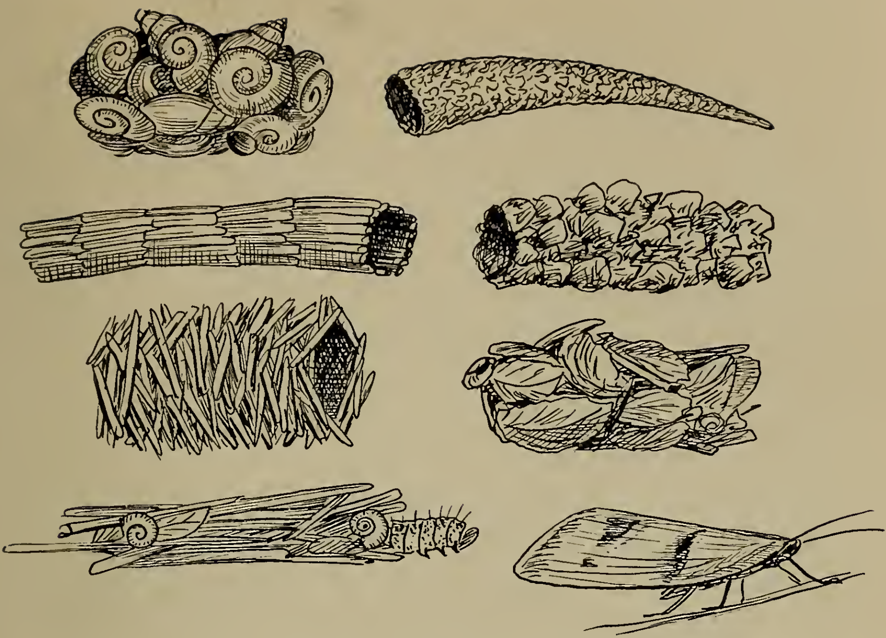
To collect the specimens, visit the nearest water course, lake, or pond, and while standing at the edge of the water dig and scrape up a scoopful of the sand, gravel, or mud from the bottom. Hold the scoop with the upper edge above the surface of the water and shake it back and forth until the fine mud and dirt has been washed out and then examine its contents. You will probably find a quantity of sand, gravel, and small stones, bits of water-weeds and water-soaked chips, but you will also find a number of strange forms of life.

To examine it to better advantage dump the contents into the sieve and wash it and with the forceps pick out whatever objects you see which seem of interest and drop them into the pail partly filled with water or into jars of water. The commonest things will probably be fresh-water snails and shells, but usually there will also be fresh-water crustaceans, tadpoles, and numerous water-insects

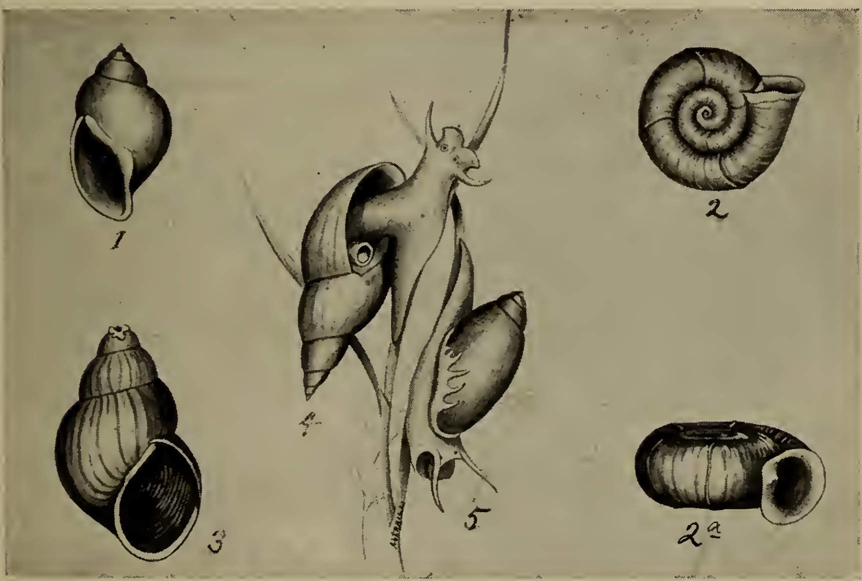
and their larvæ. There may also be fresh-water sponges—for, strange as it may seem, there *are* sponges in fresh water—and there will almost always be some odd little cones, coils, and spheres formed of bits of sticks, tiny pebbles, etc. These will no doubt prove a puzzle and if they commence to move about—as they doubtless will—you will be still more at a loss to account for them. These strange objects are the little submarine homes of the larvæ of insects called caddice flies. The adult insects are delicate, gauze-winged creatures which are often found in great swarms about electric lights. The eggs are laid in or near the water and the larvæ spend their lives on the bottom of streams and ponds. Each species builds a little home peculiar to its kind and while some are very roughly and carelessly made of bits of rubbish, others are really wonderful in their beauty and perfection of form. Some of the houses are like tiny, coiled, snail-shells; others are formed like miniature elephants' tusks; others are almost globular, and still others are merely cylindrical in form. A great many are built up from small pebbles or grains of sand; others are composed of tiny shells; some species built their homes of bits of grass or straw

so neatly fastened together that they resemble little bamboo cylinders, and one peculiar form of caddice-fly home is formed of minute twigs or straws placed criss-cross like a tiny log-cabin (Fig. 2). These larvæ are carnivorous and feed upon small creatures in the water and one species even traps its prey by building nets across the spaces between submerged rocks and thus is a real insect-fisherman. When the larvæ are fully grown they transform to pupæ within their little houses and in due time the adult insects come forth. When first hatched the fly is a bedraggled creature with tiny pads upon its back, but it immediately crawls upon some convenient object above water, spreads and dries its wings and in a short time flies gaily off as if it had always been accustomed to an aërial life, instead of having spent most of its days at the bottom of the water. Of course these strange insects really belong in the insect collection, but if you wish you may make a collection of fresh-water animals regardless of the groups to which the specimens belong and in such a collection caddice-flies should certainly be included. There are many other peculiar insects whose larval forms are passed beneath water. Among these are the lively, vicious-

looking "Helgramites" which are the larvæ of the big, gauzy-winged insects with long, sharp nippers which you often find about lights and which are a great puzzle to many young collectors (Fig. 3). This insect is known as the "Horned Corydalis" and is quite harmless, despite its villainous aspect. Another water insect which is common about electric lights is a big, hard-shelled, dull-greenish bug (Fig. 4). In many parts of the country these insects were scarcely known until after the advent of the electric lights and many ignorant people had an idea that they were connected in some mysterious way with electricity. Even to-day they are called "Electric light bugs" in some places. They are really true bugs and their natural home is in the water, but as they are attracted by lights like other insects and can fly readily they often leave their watery homes and make trips to the bright city lights—usually to their own undoing. They are powerful swimmers and live upon small fish, young frogs, tadpoles, and other water animals, and as they can bite viciously they should be handled with caution. The young collector will often find these as well as many other water bugs upon the shore of ponds and lakes. Still other crea-



2—Caddice Flies and Their Houses



5—Fresh Water Snails
(*See Chapter VI*)

The Nautilus Is Related to the Octopus

(*See Chapter VII*)

tures may be obtained by the dip-net for fresh-water life is abundant near the surface as well as upon the bottom and the forms of animal life found in the various parts of a pond or lake are quite distinct. Many of the fresh-water snails or shells are very beautiful, and a collection of fresh-water and land shells, or even fresh-water shells alone, is very interesting.

Until you commence to collect shells you will not realize what a variety may be obtained from a single small district, and you will be surprised at the number of forms and colors which they exhibit.

Many of the water snails are in the form of spiral coils, while others are flat coils and although the majority are "right handed," or, in other words, have the coil running from left to right, there are some species which reverse the order of things and turn from right to left (Fig. 5). In addition to these univalve or snail-shells there are fresh-water bivalve shells. Among the commonest and most attractive of these are the fresh-water mussels or fresh-water clams. Some of these are very beautiful, with variegated green or yellow outer surfaces and pink, purple, blue, or iridescent pearly interiors.

It is from these that the valuable fresh-water pearls are obtained and where the fresh-water clams are abundant the boy collector may be richly rewarded by finding pearls in the shells. In some parts of the country pearls are far more common than in others, but you can never tell beforehand where pearls may be found in fresh-water clam shells. In some of the western streams pearl fishing is a regular industry and in many places the shells have been nearly exterminated by the persistent fishermen. But pearl-bearing, fresh-water clams are not confined to the West. Many of the brooks and streams in Maine and other Eastern States teem with these shells and thousands of dollars' worth of pearls are obtained from the Maine fresh-water clams. I have seen single pearls worth nearly one thousand dollars taken from shells found in New England brooks. Fishing for fresh-water pearls is almost as exciting and fascinating as hunting for buried treasure and, what is more, the pearl hunter stands a far better chance of success than the usual treasure hunter. Of course every shell does not contain a pearl—you may open thousands without finding a single pearl, but then again you

may find a dozen or more little pearls or even one huge pearl in the very first shell you examine.

Some of these fresh-water pearl shells are very thin and fragile but others are heavy and thick and the latter are often of commercial value as they are used in making mother-of-pearl buttons. Although at first you may not note much difference between the various fresh-water clams, you will find if you examine them that there are a great many species, especially in the brooks, rivers, and lakes of the Middle West. In this section fresh-water clams abound and specimens of their shells alone will make a large collection.

Even if you do not collect specimens of fresh-water life, you should not fail to visit the bodies of water in your neighborhood and study the many strange creatures that you'll find there, for if you are interested in nature or in animal life you will find a lake or mill-pond a veritable wonderland.

CHAPTER VII

MARINE ANIMALS

INTERESTING and numerous as are the forms of life found on the land and in fresh water, you will find salt-water animals even more numerous and more interesting.

In the waters of the ocean and upon its shores dwell vast numbers of creatures, whose presence is scarcely suspected by most people, and among these are innumerable forms not represented among land or fresh-water animals. Many of the salt-water animals are of great value or importance to mankind and all have modes of life, habits, or characteristics which are most interesting to study.

The boy collector who has made a collection of fossils will find a great fascination in adding specimens of marine life to his collection, for many of the marine animals are identical with, or closely related to, fossil forms and thus serve to link the present with the inconceivably distant past.

For the boy who lives near the seacoast the ocean

and its shores afford a wonderful field for collecting, and a collection of marine animals is invariably interesting and instructive. Moreover, and most important of all in the estimation of many, is the fact that you are not doing any injury when you collect marine animals, for they are so marvelously abundant and increase so rapidly that all the boy collectors in the country could not make any impression upon their numbers, even on one small portion of the coast. Marine animals may be divided into several general classes, or groups; such as, *Shore animals,* or those which are found between high- and low-water mark; *Shallow-water animals,* which occur below low-water mark, but at no great depth; *Deep-water animals,* which are only found at considerable depths; and *Surface animals,* which swim or move about freely at or near the surface of the sea.

Each of these groups grades into the next more or less, for many shallow-water forms also occur in deep water; many shore-living forms are found far below low-water mark; and many surface animals live some of the time at the bottom of the sea. In still other instances the larval or young forms of surface animals live upon the bottom,

while in other cases the young of sluggish or fixed-bottom forms swim freely about on or near the surface.

For this reason the collector of marine life must be prepared to seek his specimens in all parts of the sea, even if he confines himself to one class of marine life. If several boys work together it will be far more satisfactory, for no one boy or man can hope properly to preserve, prepare, classify, and arrange *all* the forms of salt-water life. If several boys work together, however, one may specialize on shells and molluscs, another on crustaceans, another on radiates, etc., and each boy can collect everything he finds and the specimens can then be properly divided among the several collectors.

The best place to commence collecting marine life is along the shores between tides, and to properly collect the shore life of even one district will occupy most of your time for one season.

Shore Animals

For collecting shore animals you will require comparatively few tools and appliances and all of these are easily obtained with little or no expense. The most important are: a stout shovel or spade;

a trowel; a hoe or clam-digger; an old knife; forceps; a number of bottles or jars filled with alcohol or formaldehyde solution; an old basket or pail in which to carry the bottles, and a suit of old clothes and some rubber boots.

The spade, hoe, and shovel may be left out and you will still be able to obtain a great many specimens, but you will find these tools mighty useful. Moreover, if the shore is rocky a good hammer and a short bar of iron will come in handy.

Although rubber boots are mentioned these are not essential, for if you don't mind getting your feet wet you can wear old leather or canvas shoes, or you can even go barefooted if you wish.

The best time to start out is just as the tide begins to fall and on days when the tide will be very low you will find more specimens than at other times, as more of the shore will be left by the receding water. Even before the tide commences to ebb you will find a number of good specimens which have been thrown upon the beach by the waves among the dead seaweed and other trash. As a general rule such specimens are dead, worn, broken or faded, and are seldom really good specimens suitable for a collection; but in this flotsam and

jetsam you will usually find a few things which may be saved and which are excellent for your purposes. Among these are the dull-yellow or brown parchment-like egg cases of the big "winkle" shells (Fig. 1). These look like a lot of lozenges strung together and often puzzle people who are ignorant of their origin. Usually these egg-cases are empty, as the young shells have emerged through tiny openings in the cases, but quite frequently, if you cut them open, you will find numbers of perfectly formed baby shells inside.

Other objects which are common upon beaches are black, rubber-like, squarish affairs with slender filaments at the corners (Fig. 2). These are the eggs of the odd fishes known as "skates." Sometimes you will find somewhat similar egg-cases with longer, twisted filaments and these you may know as the egg-cases of sharks.

Among the trash upon the beaches you will also find many shells which are perfect enough to keep. The spiral or coiled forms, or univalves (Fig. 3), are usually fairly perfect unless water-worn, but the clam-like, or bivalve, shells (Fig. 4) should not be preserved unless both halves of the shell are connected, for a single valve is of no particular use or

FIG. 1

FIG. 2

FIG. 3

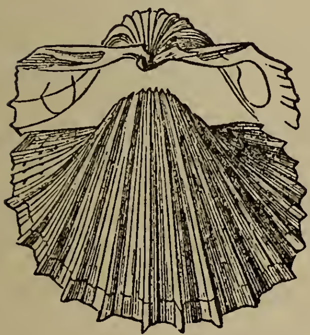


FIG. 4

FIG. 5

FIG. 1. Eggs of winkle shell. FIG. 2. Skate's egg. FIG. 3. A univalve shell. FIG. 4. Bivalve shell. FIG. 5. Hermit crab in shell

interest except in the case of very rare species.

In the half-decayed, damp seaweed you will be sure to find quite a number of small lively crustaceans and quite frequently a good-sized crab may be discovered. As the tide falls, walk along the edge of the water and look carefully for any creatures which may be moving about, either within the water or on the shore just exposed by the tide.

You may not see anything at first, but if no animals are visble you can often find them by digging into the damp sand or mud, for a majority of the shore animals live in holes or burrows.

You may dig out a quantity of sand with the hoe or clam-digger and sift it through a sieve, you can go over it carefully by hand or you may hunt for the openings of the animals' homes and dig them out with the spade or shovel. Many of these burrowing creatures betray their whereabouts by little piles of sand above their homes, by tiny tubes projecting upwards, by holes in the surface of the shore, or by little jets of water which spurt up as you approach. A great many of these animals live but a few inches beneath the surface, while others burrow very deeply. Many of these creatures can dig very rapidly and if alarmed or disturbed will

retreat to the bottoms of their holes and bury themselves deeper and deeper almost as fast as the collector can dig with a spade. To secure these, shove the spade down its whole length with one stroke and in this way try to obtain the animals before they can get well started on their retreat. The farther the tide recedes the more abundant will you find the shore creatures and you should continue to collect until the rising tide again covers the beach. You should search mud flats and rocky shores as well as sand beaches, for each kind of shore has creatures peculiar to itself and while some forms may be found on all sorts of shores, others are only found among rocks, others in sand, and others in mud.

It is far more disagreeable to collect on mud-flats than on clean sandy beaches, but many of the mud-loving creatures are far more interesting and beautiful than those which dwell in sand, and as a rule they are far more abundant.

Rocky shores afford a very rich collecting ground and you may spend many hours or days searching under the rocks and stones, among the seaweed-filled crevices, and in the cool, clear, pools of water left by the falling tides.

In such places you will find starfishes, various crabs and crustaceans, many hermit crabs—with their shell-houses on their backs (Fig. 5), spiny sea-urchins (Fig. 6), beautiful sea-anemones (Fig. 7), and many kinds of shells and other creatures.

If you wade about, or paddle about in a boat among the spiles of old docks and wharves you will also find a great variety of animals, and while some of these may be the same as those found upon the shores, others will be quite different. Among these are the delicate Serpent-starfishes (Fig. 8) and beautiful naked-molluscs—gaudy with multi-colored, fringe-like organs (Fig. 9)—and which bear but little resemblance to the common shells and snails to which they are so closely related.

Animals Below Low-Water Mark

Although there is such an array of animals to be found between high and low water there are still more which are seldom seen above low-water mark. These are known as shallow-water animals, and while some of them may now and then be found in tide pools among rocks, or cast upon the shores and beaches, the majority must be sought in their natural haunts.

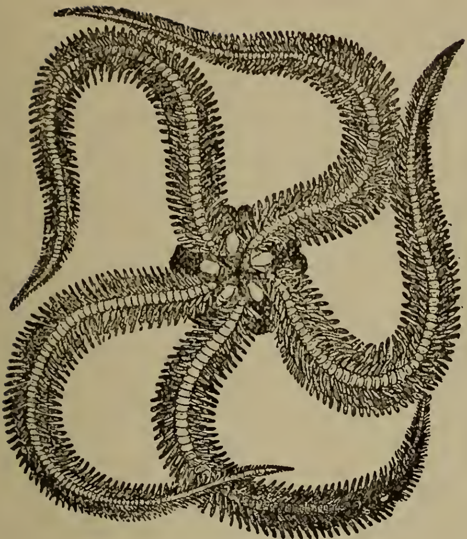


FIG. 8

FIG. 7

FIG. 10

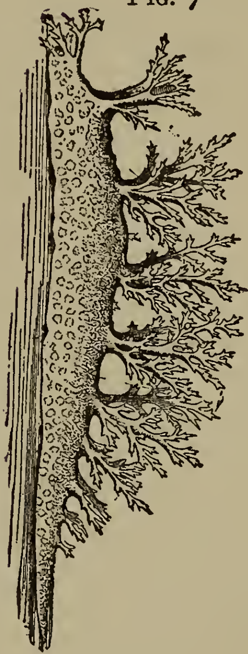


FIG. 9

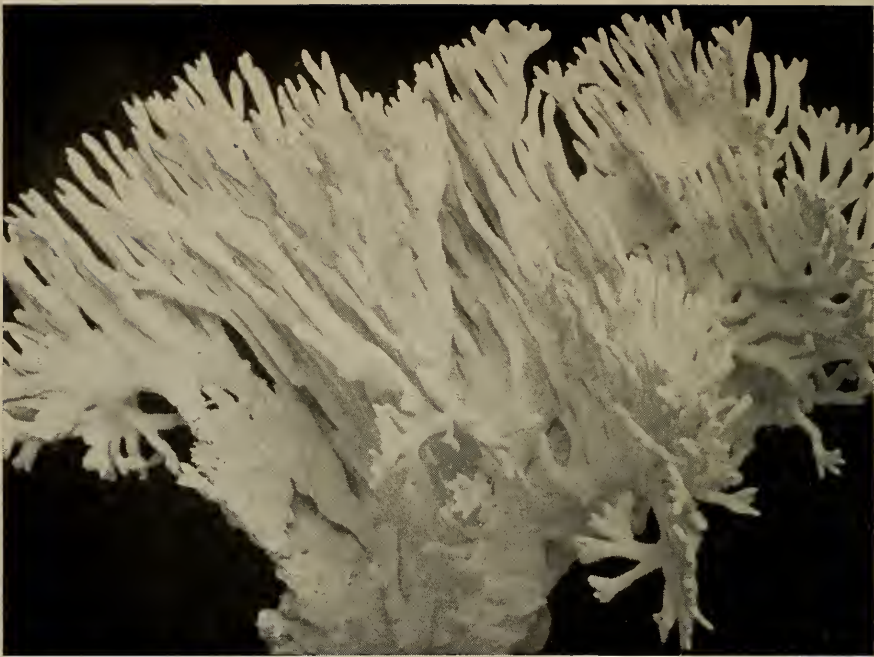
FIG. 7. Sea anemone. FIG. 8. Serpent starfish. FIG. 9. Naked mollusc. FIG. 10. Swimming crab

To collect these you must not be afraid of getting wet, but must wade about knee-deep, or even deeper, while turning over stones, digging into the sand or mud, pulling up eel-grass and weeds, and in fact exploring every nook and crevice in which animals could find a hiding place. In this work the dip-net and the hoe are the most useful tools, for a large proportion of the shallow-water animals swim freely and rapidly, especially if disturbed, and these must be captured with a net. Among this class of animals are the various swimming crabs (Fig. 10) and many other interesting crustaceans. Other forms of life dwell upon the bottom and may be readily scooped up with the net. Such are the sand-dollars (Fig. 11) and sea-urchins, while still others live upon the under surfaces of stones or in crevices of the rocks. Here you will find many sea-anemones, starfishes, crabs, serpent-starfish, shells, marine-worms, and even the beautiful native coral, which looks at first glance a great deal like a group of pretty sea-anemones (Fig. 12). It may surprise you to learn that corals are found in the North, for we usually associate them with warm or tropical seas, but the common native coral is found as far north as New England and often

11—Sand Dollar

6—Sea Urchin

14—Wood Bored by Ship Worms
(*See Chapter VII*)



30

31

30—A Perfect Coral Specimen. 31—Gorgonia with Expanded Animals
(*See Chapter VII*)

occurs in tide pools or among rocks left exposed at low tide. In deep water there are numerous species of corals in the North and many of them, of very beautiful form, are found as far north as Greenland and the Arctic Ocean. Sponges are another group of marine animals which are commonly

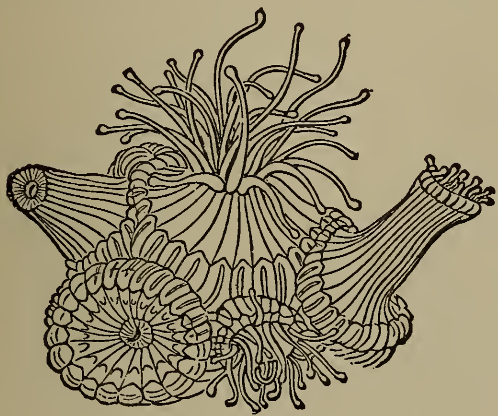


FIG. 12

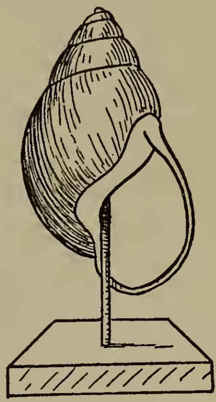


FIG. 28

FIG. 12. Native coral animals look like sea anemones. FIG. 28. A shell mounted on a wire

associated with the tropics, but all along the Atlantic coast of New England there are many forms of native sponges, both in deep and shallow water. The common scarlet sponge, the odd finger-sponges and numerous soft, branched sponges may all be found by the boy collector near shore, as he wades about in search of specimens.

Another specimen which you should secure is the

shipworm. In reality this creature is not a worm at all, but a bivalve shell related to the ordinary clam (Fig. 13). The correct name of this odd mollusc is Teredo and it is known to every boatman and sailor as its habits are very destructive to wood or timber under water. It is an easy matter to secure a piece of wood which has been attacked by the teredos, for every old spile, and timber and most pieces of driftwood are riddled with their holes.

The holes are started when the teredos are very young and hence the exterior openings are very small and quite often a badly bored piece of wood looks quite sound and good from the outside. As soon as it is broken open, however, the wood will be found honeycombed with holes which run back and forth in every direction and while they cross and recross one another they never meet or join, although they are often so close together that a mere paper-thin partition separates them (Fig. 14). Each and every hole is lined throughout its length by a thin covering of shell and within these pearly tubes the shipworms live. If the piece of wood is old and dry you will seek in vain for the creatures which bored the holes, but if freshly cut from a

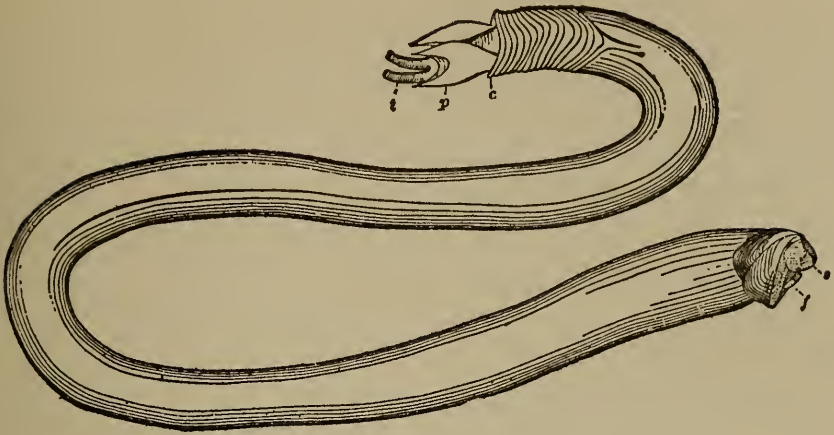


FIG. 13

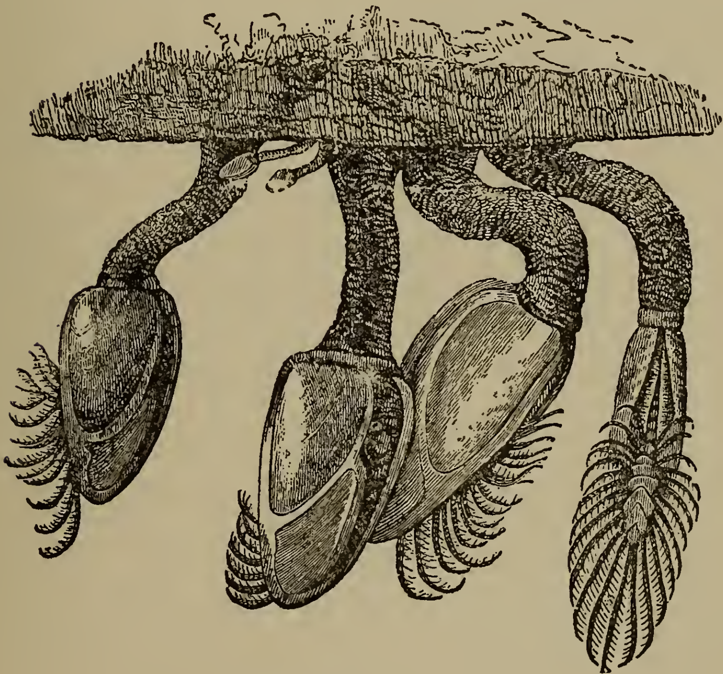


FIG. 15

FIG. 13. Teredo or ship worm. FIG. 15. Goose barnacles

submerged timber, you will find the tubes occupied by the long, slender, worm-like teredos. These shipworms should not, however, be confused with the goose-barnacles (Fig. 15) which are often found clinging to ships, boats, floating timbers, and the spiles of wharves. The goose-barnacles are crustaceans and do not bore, and the only reason that barnacles trouble ships is because they drag in the water and impede the speed and progress of the vessel.

As barnacles, shells, and weeds grow very rapidly, ships and vessels must be frequently cleaned and scraped, and if you live within reach of a dry-dock where this is done, you will find a wonderful assortment of specimens in the material taken from the planking of the vessels. If the ships have come from the North after a long voyage you will find many rare northern species of animal life, while if they have been traveling in southern seas you will find many tropical forms. Whaling ships especially are good collecting places, for they are often at sea for two or three years without being scraped and in that time an immense amount of growth accumulates upon them. Quite often good-sized and beautiful corals are found upon the bot-

toms of ships, as are sponges, sea fans, gorgonias, and beautiful sea-anemones, while crawling about among the accumulated growths you may find strange exotic crabs, crustaceans, naked molluscs, shells, and even small fish.

Everything you collect will prove so interesting that you will be anxious to collect more specimens and you will soon long to secure specimens from the real bottom of the sea.

Deep-Water Animals

This is not at all difficult if you have the proper appliances and you will find the work even more interesting than collecting the shallow-water forms of life.

Aside from a boat of some sort the appliances required for deep-water collecting are a dredge, a trawl, tangles, and the usual bottles, jars, pail, forceps, and preservative solutions. A sieve will also be useful and a pair of oystermen's tongs will be very convenient at times. The dredge (Fig. 16) consists of an iron, rectangular frame *A*, to which a stout netting bag *B* is attached and over this is a strong, open-ended bag or cover of canvas *C*. The net and canvas should be fastened to the frame

by copper wire or tarred rope and the net may be either a ready-made dredge-net or it may be made from an old fish-net. The iron frame can be made by any blacksmith, or even by a boy who is familiar with iron work, and for your work a light frame of

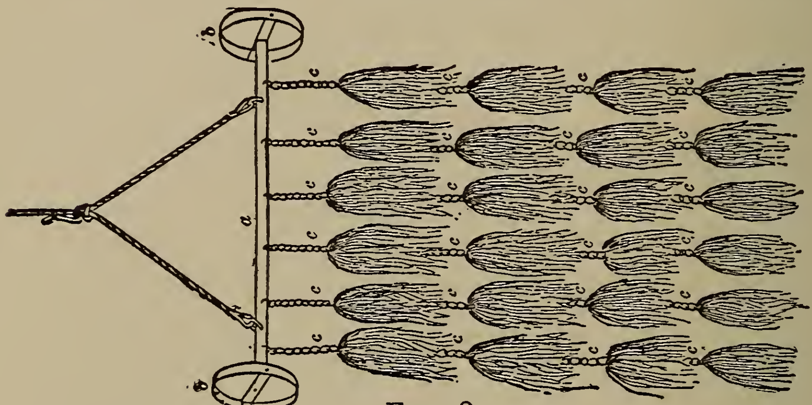


Fig. 18

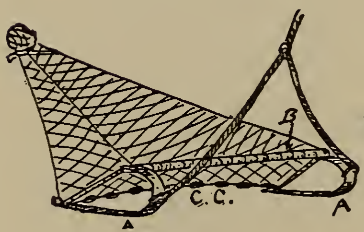


Fig. 17

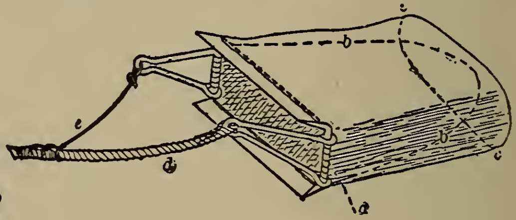


Fig. 16

Fig. 16. Dredge. Fig. 17. Trawl. Fig. 18. Tangles

¼-inch iron will be strong enough. Instead of using a regular bag-net it is often advisable to leave the end of the net open and merely tie it together with rope or string. This saves dumping the dredge upside down and when used on muddy or

soft bottoms it will prove a great convenience. The rope for lowering and hauling the dredge should be attached as shown in the illustration, as by this method the light line *E* will break and allow the dredge to swing end-on, in case it becomes fouled upon a rock, wreck or other object. A few feet in front of the dredge you should fasten a good-sized weight to the rope, as otherwise the edges of the dredge will lift and jump, as it is hauled over the bottom, and the catch will be small. The trawl (Fig. 17) is also made from an iron frame and a net, but the frame is very different in form from that of the dredge and there is no outer canvas covering to protect it from injury. The two runners of the trawl frame *AA* may be of light, flat iron and the beam *B* may be of wood or iron, or a piece of iron pipe may be used. Only the upper edge and sides of the net are attached to the frame, the lower edge being left free and weighted with pieces of lead as shown at *C*. The tangles (Fig. 18) are easier to make than either the dredge or trawl and in many places are even more useful. They consist of a number of pieces of iron chain *CC* fastened to a straight iron or wooden beam *A* and with masses of raveled rope fastened

to the links. The ends of the beam should be provided with runners, or wheels *B,* to prevent the ends from catching on the bottom or among rocks as well as to hold the beam a short distance above the bottom of the sea.

The oyster-tongs (Fig. 19) may be bought ready-made and are inexpensive and as they are very useful things every boy collector of marine animals should have a pair.

Each of these appliances has its own purpose and use, although all are used in deep-water collecting. The dredge should be used on muddy or sandy bottoms, the trawl on sand, mud, or mixed bottoms, and the tangles in any place, but by preference upon rough or rocky spots, where the dredge or trawl would be torn and injured.

The purpose of the dredge is to scrape up the sand or mud with the animals it contains, and in order that it may dig well into the material the edges of the frame are made sharp and flaring as shown in the cut.

The trawl works in quite a different manner, for instead of scraping up the mud and sand the trawl merely captures creatures which project above the surface of the bottom or are moving near it, as well

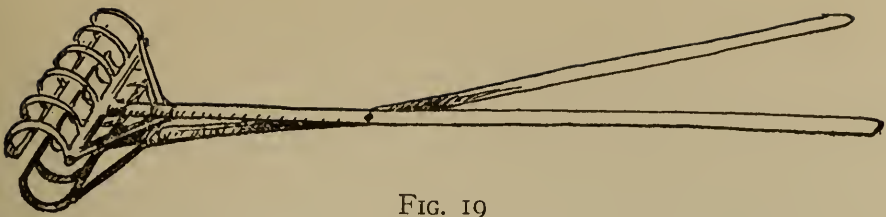


FIG. 19

FIG. 21

FIG. 20

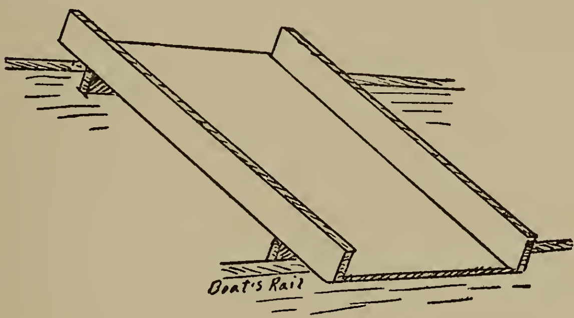


FIG. 22*A*

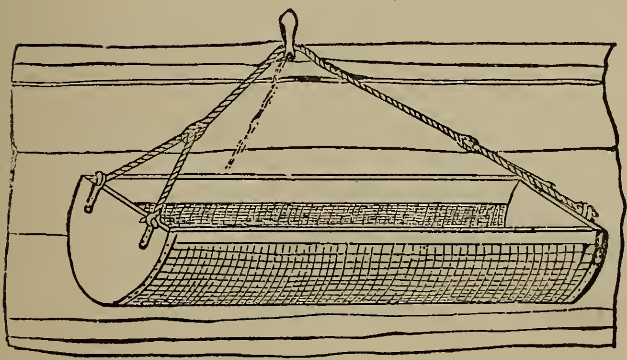


FIG. 22*B*

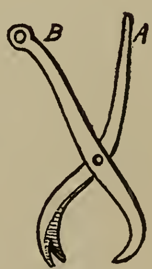


FIG. 23

FIG. 19. Oyster tongs. FIG. 20. How to dredge from a launch. FIG. 21. How to dredge from a sail boat. FIG. 22*A*. Tray to go across a boat. FIG. 22*B*. Sieve for side of boat. FIG. 23. Nippers for collecting corals, etc.

as animals which are alarmed or disturbed by the trawl's approach. The tangles operate on an entirely different principle from either the dredge or trawl and capture marine creatures by entangling their spines, projections or fins in the masses of raveled rope. Sometimes a dredge or trawl is provided with a tangle at the sides or end, so that one apparatus serves a double purpose. This is an excellent plan if you have a large sailboat or a power boat to use in dredging or trawling, but if you use a small sailboat or a rowboat you must employ a light, small dredge or trawl and separate tangles.

To use the dredge, trawl, or tangles they are dragged along over the bottom from a moving boat, but in order to accomplish the work safely and successfully you must know how to handle the boat as well as the proper method of dragging the appliances. To dredge or trawl from a rowboat it is only necessary to throw the appliance overboard, and after paying out the proper amount of rope row along until you are tired or until you think enough of the bottom has been covered. To tow a light dredge or trawl is often hard work in a rowboat, especially in rather deep water, and you'll find it

much easier if you select a place where there is a good, strong tide or current and then row *with* the tide. In fact it is quite often possible to let the current or tide carry the boat along without effort on your part, save to keep the boat in the proper position. If the current is very strong and the boat is fairly large the dredge line may be paid out from the bow and the boat will then drag the dredge exactly as if she was dragging her anchor. In the case of a smaller boat, or where there is less current, a bridle-rope may be fastened to bow and stern and the boat may then be allowed to drift sideways to the current. With a power boat the work is still easier and the only trouble will be to run slowly enough to prevent the line from catching in the propeller. To prevent this it is often a good plan to pass the dredge-line from the bow and run the boat backwards, which is the usual method followed by large vessels in deep-sea dredging. If, however, the line is paid out amidships and the boat is kept circling toward that side, as shown in Fig. 20, there will be no danger of fouling the rope, unless the current is so strong that it carries the boat off her course.

If you use a sailboat the dredge or trawl should

be dragged slowly along behind the vessel and in order to proceed slowly enough it is often necessary to reef down the sails, even in a light wind. The best position for dredging with a sailboat is to lead the rope of the dredge over the windward quarter and sail on the wind (Fig. 21). It is a dangerous matter to attempt to dredge when running before the wind, and if you attempt to dredge while running close-hauled or into the wind you will find it difficult to keep a steady pull on the line. Another advantage of sailing *on* the wind when dredging is that in case the dredge becomes fouled the boat may be brought into the wind before the rope breaks or the dredge is injured. A boat sailing in this position is also more under perfect control than at any other time.

When the dredge, trawl, or tangles have been drawn along until you think there is a good catch, pull the apparatus to the surface, souse it up or down in the water a few times to wash out the mud and slime, and then pull it into the boat. In order to save the mess and dirt from cluttering up the boat it is a good plan to have a rough wooden platform, or tray, with pieces of wood an inch or two in height along the sides, which will fit across the

boat from rail to rail (Fig. 22A), or a wire netting sieve may be fastened to the boat as in Fig. 22B.

The dredge or trawl may be dumped upon this and the contents looked over and the worthless stuff may then be easily dumped overboard without dirtying the interior of the boat. If you have been using the dredge you will probably find that a very large portion of its contents is sand, mud, or similar material, but in this you will find a large number of interesting forms of animal life. Crustaceans of odd and unusual forms, crabs, annelids, starfish, sea-urchins, sand-dollars, bryozoans, hydroids, and numerous shells are usually brought up by this method. The trawl, on the other hand, will seldom contain much bottom material, but larger and more active species of marine animals will be captured in its net. Swimming- and spider-crabs, fishes, shells, various molluscs, crustaceans, and a great many other things are captured by trawling. On the tangles you will find a great many starfishes, sea-urchins, bryozoans, and other creatures, for anything which is rough or spiny that the tangles pass over will be entangled and brought to the surface in the mass of rope-ends.

The boy who cannot have trawls, dredges, or

tangles of his own need not be discouraged, for by going out on the oyster steamers and looking over the material they bring up on dredges and tangles you will find a great number of specimens.

Still another method of collecting deep-water animal life is by means of the oyster-tongs. It takes quite a little practice to learn to use these, but it is a trick easily acquired and by means of the tongs you can obtain many large shells, starfishes, crabs, and lots of small stones and dead shells upon which you will find sea-anemones, ascidians, hydroids, and other forms of life.

If you live in the South, or spend your winters near the southern sea coasts, you can obtain very interesting collections of marine life.

In most southern seas the water is so clear you can see the bottom at great depths and with a pair of tongs or nippers you can readily secure fine specimens of corals, gorgonias, beautiful sea-anemones, curious crabs, and many species of sea-urchins. Whenever you bring up a mass of dead coral, a stone, or other object from the bottom—either in the North or South—you should examine it with care for a great many rare and interesting creatures live in the crevices of rocks and corals, under

stones, or attached to dead shells. The best form of tongs, or nippers, for obtaining specimens where the bottom is visble is shown in Fig. 23. These can easily be made by any blacksmith for a small sum and with them you can grasp and lift very heavy objects from the bottom of the sea. The stationary jaw *A* should be firmly fastened to a long, light pole—bamboo is excellent—and the movable jaw *B* may be operated either by a rope or by another smaller pole. Personally I prefer one pole and a rope, but many people find two poles more convenient. It is with such tools that the Bermudians and West Indians obtain the specimens of corals, sponges, sea-fans, etc., which they sell to tourists. They are also used in catching scallops, shells, and pearl oysters in many portions of the tropics.

If you live in a vicinity where the lobster fishermen ply their trade you will be able to secure many fine specimens of crabs, shells, and other denizens of deep water. These crawl into the lobster-pots and as they are of no value to the lobstermen they are usually killed and thrown away or broken up for bait. If you accompany the lobstermen as they haul their pots you can collect all the specimens

you desire and if you cannot do this you can easily arrange with the lobstermen to bring in any specimens they find. They will usually be very glad to do this and they'll be only too glad to furnish you with specimens if you pay them a few cents apiece for the animals you desire for your collection. Lobster-pots are cheap and are easy to make and you'll find it a lot of fun to have your own pots and set them.

Still rarer and stranger specimens may be obtained of the fishermen who sail from the various New England ports for the Georges and Grand Banks. These men often obtain remarkable and little-known specimens which become caught or entangled on their deep-sea lines. While such things are usually thrown away as worthless the fishermen will be glad to save them and bring them to you if you make it worth their while and furnish them with formaldehyde solution in which to preserve the things they capture. Even without this they will be able to keep many specimens, for a large proportion of the things they find upon their fishing lines are large and of such a character that they may be easily dried. Many of the finest and rarest forms of deep-sea life in our great museums

were obtained from the Gloucester fishermen and many species secured by them have never been found in any other way.

Of course it will be more fun and you will appreciate your collections more if you obtain the specimens by your own efforts. Whether you use pots or traps, tongs, trawl, tangles, or dredges, you will find deep-water collecting really fascinating, for you never know when some weird, new creature may be drawn to the surface from the unseen depths.

Surface Animals

Notwithstanding the great number of creatures which the collector can find upon the seashore and in deep and shallow water, there are certain forms of life which live only upon, or near, the surface of the sea.

Many of these are very strange and interesting, others are remarkable for their beauty or form or color, while still others are identical with shore and bottom animals in other stages of growth, but are so distinct in appearance that you would never guess they were even related.

To collect the surface animals the most useful

appliances are dip-nets and towing-nets. The dip-net, for surface collecting, should be of fine muslin or coarse cheese cloth and if possible you should also have an ordinary crab-net or minnow-net as well. The towing-net or drag-net should be of fine cloth, such as muslin, cheese-cloth or bobbinet, and should be of round-bottomed form with a heavy hoop. Instead of a handle this net is provided with a bridle of small line so that it may be attached to a rope and dragged behind a boat (Fig. 24). In addition to the nets you should have the usual jars, preservative solutions, forceps, etc. At first sight you may not think there is any life upon the surface of the water and you will very probably consider it useless to drag a net along, but a great surpise will await you if you tow the net through the apparently lifeless water for a little distance.

Many of the forms of life which inhabit the surface of the water are practically invisible, when seen from above, and many of them are so transparent that you can scarcely see them, even after they have been caught and placed in a jar or pail of water. Some of them become quite opaque when preserved in alcohol or formaline, however, and make very interesting and attractive specimens.

Surface animals are most numerous in the evening in summer and in calm weather, and their abundance is proved by the phosphorescence in the

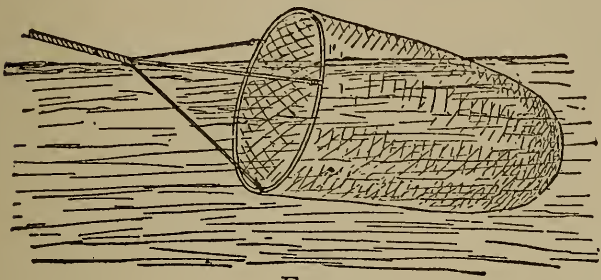


FIG. 24

FIG. 25

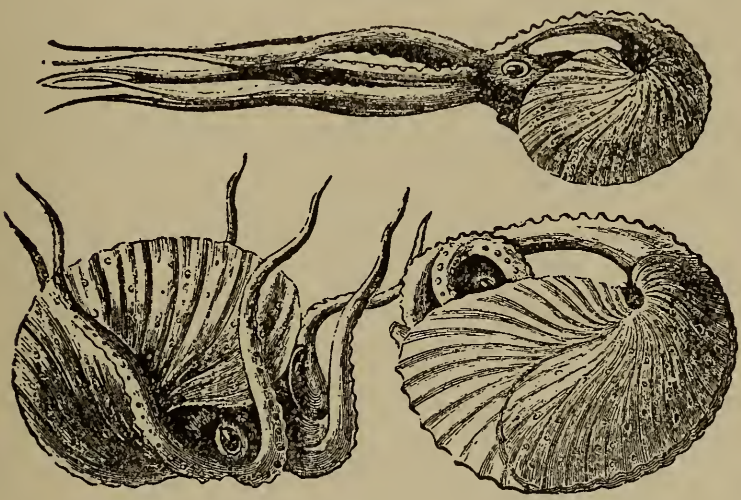


FIG. 26

FIG. 24. Towing net. FIG. 25. Pteropod. FIG. 26. Argonauts.

water, for the lights and glow in the sea are all caused by marine animals. A great proportion of these are extremely small, or even microscopic, and such of course will neither be captured in an or-

dinary net or seen by the collector if they are caught. In addition to these there are a great many large or fairly large forms which you can obtain.

After dragging the net behind the boat for some time lift it up and turn it inside out in a bucket of fresh sea-water and if you have had any success at all you will find quite an assortment of creatures which you have never before seen and which you never suspected were found in the water. There may be a few fish; perhaps some small crabs; and in all probability a number of jelly-fish. Besides these you will find some very peculiar crustaceans, so transparent that only their brilliant eyes and the contents of their digestive organs are visible as they swim about. To see these and other transparent creatures to the best advantage they should be placed in a dish of sea-water upon a dark background and if examined at night most of them will appear very beautiful with their pale phosphorescent glow lighting up their surroundings. In fact, you will soon discover that you can learn a great deal about marine life and can obtain a great deal of pleasure by keeping the various creatures which you collect alive for some time. In many cases the habits of marine animals are more in-

teresting than the creatures themselves and after watching them for a time you can either preserve them or throw them into the sea again.

Some of the jellyfishes may be preserved, but many of them are worthless as specimens and are only interesting to study while living. A great many of the surface animals are very small, but they are none the less interesting. The tiny Pteropod shells which swim freely at the surface are very odd (Fig. 25), the glass-like young of the conger eels are remarkable as they swim about with only a pair of eyes to mark their presence, and squids or cuttlefish are always interesting. If you are dragging the surface in southern waters, or even off some portions of the northern coasts, you may perhaps secure a specimen of the paper nautilus or argonaut. Although poets have sung of these creatures as sailing the sea, yet in reality they never sail, but swim or crawl about, for the argonaut is really a species of cuttlefish, related to the squids and octopus (Fig. 26). The true nautilus of the Indian Ocean is also a cuttlefish, but is very distinct from the argonaut. Many of these larger creatures may be captured with the dip-net if you see them in the water near the boat and after you have

been collecting a short time you will spy things which you overlooked before and will find there are many interesting creatures to be seen swimming about. Quite frequently the dip-net or the drag-net will be found quite filled with a soft, jelly-like, slimy substance which has little resemblance to animal life. If this is dumped into a bucket of water it will resolve itself into vast numbers of small creatures and some of these are wonderfully strange in form and habits. A great many of these are old friends in new shapes and while you can scarcely believe it, yet the big-headed, goggle-eyed creatures (Fig. 27A) are really baby crabs, the funny shapeless objects with delicate waving hairs are young oysters (Fig. 27B), the transparent things with numerous arms or appendages are the early stages of sea-urchins and starfishes (Fig. 27C), and, strangest of all the rounded, rapidly swimming animals like Fig. 27D are really barnacles. It invariably surprises the amateur naturalist to learn that such things as starfishes, sea-urchins, oysters, and barnacles swim about, for we are so accustomed to thinking of them as slow-moving, sluggish, or fixed animals that the idea of their swimming seems almost incredible. This is espe-

cially the case with barnacles, but barnacles are true crustaceans and in their internal structure are very

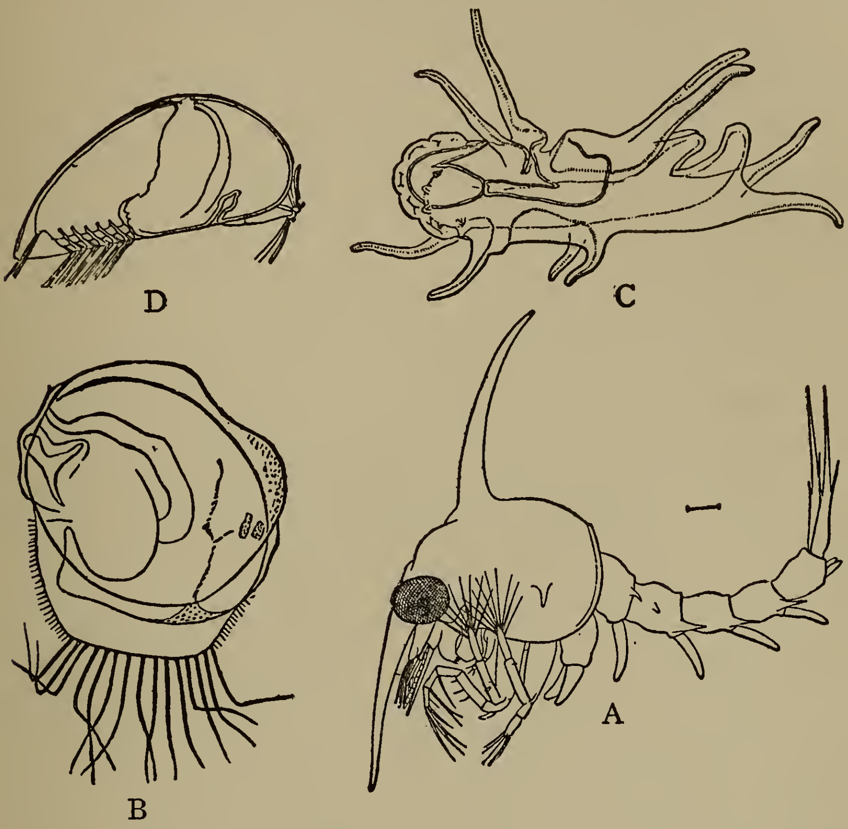


FIG. 27A. Young crab. B. Young oyster. C. Young starfish. D. Young barnacle

similar to crabs, lobsters, and shrimps. About the only difference is that barnacles develop shells within which to dwell and settle down to a sedentary life in one spot instead of leading a nomadic existence like their cousins the crabs.

Preserving, Preparing, and Classifying Marine Animals

The majority of marine animals are very easy to preserve and prepare and in most cases it is only necessary to drop them into alcohol or formaldehyde solution. Other animals are more attractive when dried, while some things are so difficult to preserve that they are seldom seen in the largest museums and even when they *are* preserved they are so shapeless, distorted, or unsatisfactory that they are not worth the time and trouble expended upon them.

Practically all the larger crustaceans, such as crabs, lobsters, etc., may be dried, but they should first be soaked thoroughly in alcohol or formaline. They should then be placed upon a board, their legs and appendages should be arranged in a natural attitude, and the specimens laid aside in a dry, cool spot until thoroughly hard and rigid. They should then be mounted upon suitable bases or pedestals, by placing a column or support of some sort beneath the body. Either a little peg, or several pegs of wood, bottle-corks, or plaster columns may be used as supports and the specimen should be se-

curely glued to these. Where the tips of the legs or claws touch the base they may be fastened with drops of glue to secure them more rigidly.

If the natural colors fade the crustaceans may be touched up with oil colors and a fine brush, but they should *never* be varnished or shellacked. All danger of cracking or breaking as the specimens dry may be avoided by adding a small quantity of glycerin to the preservative solution, but if too much is added the specimens will never dry.

Shells may all be dried after soaking in alcohol and then removing the animals, but it is always a good plan to preserve a few in formaldehyde with the animals in the shells. Shells may be mounted upon flat bases, or in the case of univalves the shell may be supported upon a stiff wire set into a base. The upper end of the wire should be wound with cotton, coated with glue, and set into the shell as shown in Fig 28 (p. 161). Starfishes, sea-urchins, and sand-dollars should also be soaked in preservative and dried, but starfishes should first be soaked in fresh water for a few hours until they are plump and fully expanded. They may then be soaked in formaline and then spread in a natural position on a board to dry. Oftentimes starfishes dried in a

fairly warm oven or upon a bed of hot sand will be much plumper and more natural than if dried in a cool spot. Some of the serpent starfishes break into many pieces if dropped into alcohol or formaline and in such cases the creatures may be killed by placing them in fresh water, or in benzine or gasolene.

Before killing starfish, sea-anemones, marine-worms, and many other of the lower forms of marine life it is a good plan to add some magnesium-salt solution to the sea-water in which they are placed. This not only stupefies the creatures and renders them insensible to any pain or sensation, but it also causes them to expand very beautifully. Shells may thus be treated and preserved with the animals fully expanded, whereas if placed directly in alcohol or formaline the animals will be drawn out of sight within the shells.

Sponges also may be soaked in preservative and dried, but corals must be treated in a different manner. Corals, when alive, are very brilliantly colored, for the animals cover the entire surface and when expanded appear like sea-anemones (Fig. 29). By placing the freshly obtained, live corals in water with magnesium-salt solution added, the animals

will expand and they may then be preserved in alcohol or formaline. Such specimens are always of great interest, for few people realize what coral animals look like. The majority of corals, however, are preserved dry and bleached and to do this properly you should first soak them in fresh water and potash (or lye) until the animal matter is dis-

Fig. 29. A living coral with some of the animals expanded

solved, after which they should be thoroughly washed in fresh water—the stream from a garden hose is excellent—and the cleaned coral should then be dried and bleached in the brightest sunshine. The beauty and perfection of coral specimens depends upon the care used in cleaning and drying, for if any animal matter is left adhering to the

coral, or if the specimens are dried in the shade or are exposed to alternate rain and sun, the specimens will be discolored, mildewed, and moldy. Well-preserved corals should have every calicle clear and distinct and should be snowy white in every part (Fig. 30). Gorgonias, which include the so-called "sea-whips" and "sea-fans," are simply dried after soaking in preservative solutions, although some of the larger kinds may be kept in alcohol or formaline with the animals expanded by first treating them with magnesium as already described (Fig. 31).

Worms, annelids, naked-molluscs, squids, jelly-fish, and the various larval forms of marine life, as well as all other soft-bodied creatures, must be kept in alcohol or formaline, and the only way to determine whether or not such things can be preserved is to experiment. Finally, there are the sea-weeds, and these make very attractive and interesting collections. To preserve seaweeds, first place the specimens in clean sea-water and separate the various individuals and varieties. Then with the forceps lift the specimen to be prepared and drop it into a dish of fresh (not salt) water and slip a piece of white, stiff paper or thin Bristol-board beneath it. Spread the weed in a neat and pretty position

over the paper, while holding the latter with just enough water to cover it, for if there is too much water over the card the weed will wobble and float about and you'll find it almost impossible to arrange it. When the weed is properly spread lift the paper carefully, drain off the surplus water and set it upon a clean pad of blotting paper to dry. If desired a second sheet of blotting paper may be placed over the weed and pressed firmly upon it and if this is done carefully very flat and smooth specimens may be obtained. The preserved sea-weeds may be kept in an album or portfolio or they may be prepared for exhibition by placing them in glass-covered mounts such as are used for insects.

In classifying the marine collections great care should be used and you will have to depend largely upon text books and museum collections for identifying your specimens. Nearly all the ordinary forms of marine life are described and figured in various books and if you cannot find a figure or description which fits a certain specimen take the specimen to some zoologist who has studied marine life. It may prove to be some common, well-known thing which the books omitted, but it may be some new and undescribed species, for despite the care

and attention which scientists have given to marine life new and unknown things are being constantly discovered.

In labeling your marine specimens follow out practically the same methods as described for other specimens. Provide each specimen with a number and catalogue it and be sure to have this number *attached* to the specimen and not merely in the bottle, tray, or case with it. In addition provide each specimen with a good label. In the case of dried specimens this may be fastened to the specimen or to its mount, but in the case of specimens in preservative solutions the labels should be placed in the bottles or jars. Where the label is to be kept in a solution you should use tough parchment paper and indelible or waterproof ink. Strive to make your collection of marine specimens as instructive as possible. Keep each group of creatures by itself, all the molluscs together, all the radiates together, etc., and aim to study and learn the habits, lives, and peculiarities of the specimens while you collect them. If you do this you will not only find a greater interest in your collection but you will really have made collecting worth while.

PART II

CAMERA AND MICROSCOPE

CHAPTER VIII

PHOTOGRAPHING WILD THINGS

IN many ways a collection of good photographs of wild creatures in their native haunts, of insects, or even of plants and trees, is far more satisfactory than preserved specimens.

It requires just as much, or even more, skill to obtain photographs than to collect the objects themselves; they require far less care and trouble, they are not so easily injured, and they occupy far less space. Moreover, and perhaps most important of all, it is not necessary to destroy life of any sort in order to collect by photography and good photographs of birds, animals, insects, and other creatures give a far better idea of their appearance in life than the most carefully prepared specimens.

In the case of certain things—such as birds and birds' eggs—a collection of photographs is the only sort of collection to be encouraged, and the boy who hunts birds and their eggs with a camera will

find it far more interesting "sport" than hunting with a gun. It takes far greater skill, a much greater knowledge of woodcraft, and a more intimate familiarity with the ways of birds to stalk them with a camera and get a good negative than to follow them with dog and gun and get a good shot.

It may be true that "anything which can be seen can be photographed," but the boy who hunts with a camera will find that many a wild thing is seen which cannot be photographed, save after many attempts and a vast expenditure of time, patience, and perseverance. But when at last you *do* obtain a good picture you will feel amply rewarded for all your trouble and will have a far more satisfactory trophy of your skill than any stuffed bird, mounted head, or antlers.

Birds are perhaps the most difficult subjects to photograph, but there are many species which make excellent and easy subjects, while their nests, eggs, and young make the most attractive and interesting pictures imaginable. Animals of every kind, from moose and bears to tiny mice and shrews, may be snapped by the hunter with a camera and in the insect world there is a wonderful and almost un-

Photograph of Whippoorwill and Gray Squirrel from Life
(See Chapter VIII)

2

2—Shrike Photographed from Life

3

3—Deer, or White-Footed Mice

(See Chapter VIII)

known field for the photographer of wild things. Frogs, turtles, snakes, reptiles of all kinds and even fishes may be photographed quite readily and with proper appliances the lower forms of marine life—and even the invisible microscopic creatures—may be pictured by the camera.

Modern photography is a marvelous thing and each day improvements and discoveries are being made which make it even more remarkable and widen its field. A few years ago motion pictures of the commonest things were hailed as the last word in photography, but to-day the uttermost parts of the world—strange races and savage beasts—are shown before us with all the motion and color of life, and even the depths of the sea and its strange inhabitants are reproduced in moving pictures (Fig. 1). Not many years ago it would have been impossible to photograph birds, animals, or insects in their natural haunts, but to-day any boy who can secure a good camera may obtain a wonderful collection of valuable and interesting nature photographs.

Many things may be secured with an ordinary camera of short focus and small size, but for good work and to succeed in photographing living wild

creatures you must have a camera adapted to the work.

Such a camera is not necessarily very expensive. Of course if you expect to picture shy birds or animals, birds in flight, and many other similar things you will require a very rapid and expensive lens, a reflex or graflex camera, perhaps a telephoto attachment and numerous other expensive appliances. It is, however, far better to begin on simple subjects and later attempt more difficult things after you have become proficient. Birds' nests and eggs are perhaps the easiest subjects for beginners. A short time exposure is preferable to an instantaneous exposure in all cases and when photographing nests and eggs this is possible, whereas in photographing living birds, animals, insects, etc., an instantaneous picture must be taken. When photographing nests use every care not to disturb the nest or its surroundings. If the nest is hidden among brush or foliage do not *cut* the surroundings but push them gently to one side or both and if necessary tie them in position and replace them in their original position after the picture is taken. Never touch eggs or nests, for if you do the parent may desert her nest and leave the eggs to spoil.

If the nest is in an open situation there will be little difficulty in securing good, even lighting, but if in the woods or in brush there will be patches of light and shadow thrown upon the nest and these must be avoided. Streaks and spots of brilliant light confuse the outlines of the picture and while making the exposure a cloth or some other screen—even a large hat will answer—should be held between the sun and the nest so as to cut off the direct light and produce a soft diffused light. Stop the lens down to secure sharp details and give an ample time for full exposure; fuzzy, indistinct, or under-exposed, contrasty pictures are not suitable for nature photographs, no matter how "artistic" they may be. Always endeavor to photograph the nests with enough of their surroundings to give a good idea of their situation. Sometimes it's an excellent plan to make a photograph of the nest as it appears nearly or quite concealed among the grass or leaves and then take another picture with the foliage pushed aside to reveal the nest and eggs exposed. The greatest interest in many nests is the manner in which they are hidden or the form in which they are built to avoid being seen. In such cases two pictures should always be taken.

Thus the nest of the oven-bird is roofed over and is scarcely distinguishable from the ground upon which it is placed. A picture of such a nest, taken from the point of view of the passer-by is interesting and valuable as illustrating the clever manner in which the nest is designed to avoid discovery. Such a picture would not give any idea of the actual construction of the nest or the appearance of the eggs, and hence a second photograph should be taken with the camera placed close to the nest and near enough the same level to show the opening and the eggs within. In the case of nests in tall trees one picture should be made from the ground showing the nest in the tree and another picture should be made at close range to show the form and structure of the nest and the eggs it contains. A great many birds lay their eggs in holes in banks, trees, and similar situations and to secure pictures of these, showing the interior of the nests and the eggs, would necessitate injuring or destroying the birds' homes. In such instances pictures of the banks or trees showing the entrance to the nests will be sufficient.

Quite frequently you will find nests containing young birds and these make very interesting pic-

tures. In photographing young birds in the nest you should work as rapidly as possible and in most cases an instantaneous exposure will be necessary. Oftentimes, however, the youngsters are good posers and will remain immovable while a short time-exposure is being secured. Even more attractive are pictures of the old birds on their nests and it is often very easy to secure splendid bird pictures in this way. Some birds sit so closely that the camera may be set up and the picture taken without disturbing the parent bird, while others will slip away from their nests at the approach of the intruding photographer. Even if the bird is not on the nest, her picture may often be secured by setting up the camera, arranging a long tube or a thread to spring the shutter and then retiring for some distance and waiting for the bird to return to her nest. The shutter may then be sprung and the picture obtained. In some cases the camera may be left in plain view, but as a rule it should be concealed or screened by leaves, boughs, or other foliage.

Some birds are so wary that it is necessary to place the camera in position and leave it for hours or even days until the birds become accustomed to

its presence. In order to avoid loss or injury to the camera an imitation camera made of wood or pasteboard may be used and after the birds have become convinced that the strange object is not dangerous the real camera may be substituted and the pictures secured. Photographs of hawks' nests and the nests of other wary birds in trees may often be obtained by arranging a thread or string from the shutter so that the bird itself makes the exposure when it settles upon its nest.

Birds feeding their young also make excellent subjects and they are often so intent upon satisfying their youngsters' appetites that they pay little attention to the photographer or his camera. Of course such pictures, as well as pictures of the birds upon their nests, must be instantaneous, and a very rapid lens and the most rapid plates must be used. Orthochromatic plates give far better color values than ordinary plates, but they are not as rapid and while they are advisable where a full exposure is possible they can scarcely be recommended for instantaneous work, save in bright sunlight. Even if the pictures of the nests or birds are small they can be enlarged, if the outlines are clear and the details sharp, but the larger the subject in the pic-

ture the better, and to obtain large pictures a long-focus, good lens is essential. Small film cameras may be used in some cases if you have nothing better, but a plate camera with a long draw bellows is preferable. Plate cameras are better than film cameras for nature work for it is an important matter to focus the object to be taken on the ground glass, and, moreover, as each exposure will be made under totally distinct conditions every negative should be developed separately.

Use great care in developing, using some rather slow developer in order that the plate may be under perfect control. Have two solutions ready, one a weak, powerful developer for under-exposures and the other a strong, slow-acting developer for over-exposures. Start the plate in the weak solution and if it shows symptoms of full or over-exposure immediately transfer it to the other tray. Develop for detail and carry development to the limit. Personally I prefer *rodinal* for the short and instantaneous exposures and *hydrochinon* for the others. A very thin negative full of detail may be made into a dense, fully developed negative by immersion in hydrochinon with a little bromide of potassium solution added, and by using rodinal first

and hydrochinon afterwards almost any negative may be saved, except those which are hopelessly underexposed. Rodinal is particularly valuable as it never fogs a plate and negatives may be left in it for hours without danger. Hydrochinon does *not* fog but it produces contrasty, dense negatives, and is excellent for full time exposures and over-exposures as well as for deepening the development after the details have been brought out by the rodinal.

In warm weather negatives frequently soften or "frill" during development, fixing, or washing. This may be entirely overcome by adding a few drops of formaldehyde to a tray of water and by immersing the negatives in this solution. The plates should not be kept in the solution *too* long however. A good way to judge of the time they should be immersed is to press upon the film on the plate with your finger nail. As soon as the film loses its soft, slimy, feeling and your nail cuts into it with a little snap the plate should be taken from the solution. Never treat the plates with formaline before developing, but either dip them into it after development and before fixing, or better still, after they are fixed and before they are washed. Formaline has

a wonderful property of removing the hypo and plates soaked in the solution after fixing may be washed in half the time required to remove the hypo when they are not treated with the formaline.

Many of the foregoing suggestions apply equally well to photographing the birds themselves, but of course it is seldom possible to set up a camera on a tripod to take the birds' pictures. Where a sleepy owl is found dozing during the day this is possible and many hawks and other birds return repeatedly to the same perch so that a camera may be set up and arranged with a string to snap the shutter so that the bird takes its own picture, but these cases are the exceptions rather than the rule. Sometimes a small tent may be concealed near the haunts or nests of birds and the pictures may be taken through an aperture or the camera may be hidden outside and may be sprung from within the shelter.

By far the greater number of bird photographs are snap-shots, however, and the success of the photographer depends upon his knowledge of bird-life and habits, his ability to approach the birds without alarming them, and his skill with the camera, as well as upon the quality of the camera and lens. Moreover, it is far easier to secure pic-

tures of wild birds in some places than in others. On bird preserves, or where birds are rigidly protected, in rookeries and on the breeding grounds of water-fowl and seabirds it is usually very easy to secure good pictures. Many of the wildest and shyest birds become ridiculously tame when at their breeding grounds and will scarcely move out of your way as you walk along. Gulls, terns, pelicans, herons, and many other birds are about as tame and as easily photographed as domestic fowls when at their rookeries or breeding places, and any one can secure all the pictures he desires with an ordinary camera in such places.

To take pictures of wild birds in the woods is quite a different matter and if you get one good negative out of scores of exposures you are doing well. But if you expect to get any results in this class of nature photography you must have a long-draw camera and a lens which is exceedingly rapid and which will produce a very large image on the plate. Telephoto lenses are all very well for photographing distant objects, but they are slow and cumbersome and cannot be used to advantage in securing snap-shots of wild birds in the woods and fields. A very good arrangement is to use a

large lens on a fairly small camera. A lens which is designed to cover a plate of 8x10, 11x14 or some similar size, if fitted to a 4x5 or 5x7 camera, will produce a very large picture without the trouble of carrying a big camera. Of course the field of such a large lens is small and it is very difficult to be sure that the object snapped will appear upon the plate, but after a little practise you will learn to judge directions and distances so well that you will seldom have trouble on this score.

Before using the camera you should set it up and focus it on objects at various distances and mark a scale upon the bed to guide you. Even with a rather small lens very satisfactory results may be obtained, for if the lens is a good one and gives a sharp, clear image the picture may be successfully enlarged. The photograph of the butcher-bird or shrike in the illustration (Fig. 2) was a mere speck on the original negative and many of the most striking and remarkable bird photographs ever taken were very small indeed upon the original plates.

Photographing wild animals is often far easier than photographing birds. Large creatures, such as deer, moose, etc., may often be taken very easily during the close season or on game preserves, but

even the smaller species, such as rabbits, squirrels, and wild mice are not difficult subjects (Fig. 3). Very often these chaps may be attracted within camera range by means of bait and frequently the animal photographer arranges a string from the camera so that the unsuspecting animal springs the shutter and takes his own picture as he nibbles the bait or passes along his accustomed runway or path. Many very remarkable photographs of wild animals have been taken by flashlight. These are secured, either by approaching the creatures at night in a boat or canoe and firing the flash by hand, or by arranging threads or strings so that the animal, when taking the bait or passing along the runway, fires the flash and springs the shutter of the camera. Photographing animals and birds is an art in itself and a volume could be written upon the subject, but the above hints may serve to help the boy collector with a camera and patience, skill, and practise will do far more than anything else to insure success in this branch of photography.

Birds and animals are not by any means the only wild creatures which make valuable and interesting pictures, however. Frogs and turtles, reptiles, snakes, and fishes may be photographed quite

easily. Sometimes a turtle, frog, or snake may be snapped as the creature suns itself upon some object, but as a rule frogs, turtles, and fish must be photographed in an aquarium at home. For this purpose the aquarium should be square or rectangular with flat sides and very narrow or shallow from one side to the other. Ordinary aquariums are usually too wide, but this fault may be overcome by fitting a sheet of glass so that it may be slipped into the aquarium and moved forward or backward as desired. The water in the aquarium must be perfectly clean and clear and the glass must be free from weeds, slime, or dirt. The pictures should be taken out of doors if possible, but a well-lighted room will answer, especially if it has a skylight. Do not place the aquarium in bright sunlight, but select a spot where there is an abundance of diffused light. Place some stationary object in the aquarium and set up the camera. Focus the camera upon the nearest glass of the aquarium and move the object within slowly toward the rear. Adjust the glass partition until all portions of the interior of the aquarium from front to rear are in sharp focus and you are then ready to proceed with the live subjects. When first placed in the aqua-

rium, frogs, turtles, and fish are usually quite excited and swim or move about very rapidly. Do not attempt to photograph them until they have quieted down and have become accustomed to their confinement. Then approach carefully, slip a plate into the camera, wait until the creatures in the aquarium are at rest or in natural attitudes and take the picture. Sometimes a snap-shot will be necessary, for the creatures may keep constantly in motion, but very often the subject will remain immovable for minutes at a time and time-exposures may be made. Do not try to photograph too many things together; it is often wise to have but one creature in the aquarium at one time, for if there are several, one may disturb another at the critical moment when the exposure is made. Pictures of frogs and turtles taken in this way often represent the animals in attitudes which are very strange and remarkable and such photographs give us a far better idea of the creatures' habits than it is possible to obtain in any other way (Fig. 4).

Marine animals may be successfully photographed in aquariums by the same methods. Crabs, lobsters, and even jelly-fish may be thus pictured in their natural attitudes and while feeding,

1—Photographing subjects in water requires painstaking care, and when successful is no mean achievement

(See Chapter VIII)

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At Top Portuguese Man-of-War, Sea Anemone, Photographed from Living Specimens; Below, Odd Positions of Turtle and Frog as Disclosed by Photography

(*See Chapter VIII*)

swimming, or crawling about and for all practical purposes the photographs are just as valuable and interesting as if taken at the bottom of the sea. Even if you collect marine specimens the photographs will be interesting and may be exhibited with the preserved animals. Photographs of such creatures as the Portuguese Man-of-War (Fig. 5), of sea anemones (Fig. 6), or of living corals, or gorgonias which show the animals fully expanded are far more satisfactory and attractive than the preserved specimens.

When taking pictures of any of these forms of water life you should place rocks, weeds, shells, sand, etc., in the aquarium, for these add greatly to the natural appearance of the photographs and they also serve to make the captive animals feel more at home.

Of all live creatures insects are perhaps the easiest to photograph and in many ways they are the most interesting.

A great many of them may be photographed in the woods or out of doors, but the best pictures are those taken indoors where you can arrange the light, the surroundings, and the subjects to suit yourself.

To photograph insects successfully you should have a long-draw camera, a rigid support of some sort, and a rapid lens. The support may be either a stand made for the purpose or a board or plank set upon two horses or benches, but the camera should be clamped to it firmly and it should be placed where there is no jar or vibration. A stand of some sort must also be arranged to hold the insects to be photographed. It is not advisable to have this connected with the camera or its support, for any motion or jar of the latter may thus disturb the insects. The stand on which to place the creatures may be very simple and the only requisites are places in which to set leaves, sticks, or other objects and a support for a background, such as a sheet of cardboard or paper. The insects to be photographed are placed upon the plants or other objects; the background, of the proper shade to bring out the subjects in relief, is placed a few inches or a foot behind them, and the camera is carefully focussed. The plate being ready and the shutter set for a bulb exposure you must then wait until the insects are motionless, and press the bulb and hold the shutter open for the correct length of time. If an insect moves, close the shutter at once.

By this method you can often obtain a fully timed exposure, while even the shortest bulb exposure will give far better results than an instantaneous picture. Some species of insects are very restless and an instantaneous exposure must be made and in such cases it is a good plan to take the pictures out of doors on a bright day, but *not* in direct sunlight. Insects as a general thing do not move very rapidly—with the exception of those in flight—and even butterflies, moths, wasps, and other winged insects will remain motionless for a long time when at rest (Fig. 7). Caterpillars after feeding are usually very sluggish and may be taken by time exposures without any difficulty (Fig. 8). In the case of active, flying insects, ants, spiders, and some other things, they should be placed in a glass cage or in a box with glass sides and photographed while thus enclosed. Very interesting subjects are butterflies and moths emerging from their pupæ and a series of pictures showing the larva, the pupa, the adult insect emerging from the chrysalis, and the same insect with wings fully expanded makes a very instructive and valuable addition to any collection. Photographs are especially valuable in showing caterpillars. Many of our insect larvæ

possess forms, colors, or habits which serve to protect them from their enemies and in some species this "mimicry," as it is called, is truly marvelous. The caterpillars of many moths so closely resemble little twigs that they are scarcely distinguishable (Fig. 24, Chapter V), while other species imitate spots on leaves, knots on wood, pieces of bark, and other natural objects. Some of the adult insects have protective colors or forms also, and moths imitate bark and lichens (Fig. 9); butterflies mimic dead leaves, etc. Still more wonderful is the form of mimicry by which harmless, inoffensive insects counterfeit dangerous or offensive species in order to escape attacks of birds and other enemies. Among the beetles there are species which imitate black and yellow hornets (Fig. 10), certain species of flies so closely resemble bees that the average man cannot distinguish them (Fig. 11), and many similar examples may be found among the commonest insects. Photographs which exhibit such protective forms or habits should always be obtained when possible, for they illustrate the wonders of insect-life in a most vivid and instructive manner and are of real scientific value.

To the boy interested in plants, woods, or any

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Photograph of Various Insects
(*See Chapter VIII*)

12—Photographs Aid in Indentifying Trees
(*See Chapter VIII*)

department of botany, the camera will prove an invaluable aid. In connection with the wood collection, or by itself a series of photographs of trees is very interesting and useful. The form and method of branching of each species of tree is usually quite typical and is an important factor in identifying the various trees. By securing good photographs of typical trees, taken in winter and summer, and supplementing these with close views of the bark, photographs of the leaves, flowers, and seeds, a most valuable and instructive collection may be formed. By studying such photographs you will soon learn to recognize the various trees by any one or by several of their characteristics. It may be quite difficult for you to distinguish the several pines and spruces, but if you have good photographs showing their leaves and cones you will find that they are all very distinct and by comparison with the pictures you will have no difficulty in recognizing all the evergreen trees (Fig. 12). Collections of pressed and dried plants and flowers are pretty, interesting and useful; but they are fragile and unsatisfactory at the best and a collection of photographs will serve every purpose and will be far more durable and will represent the

appearance of the plants to far better advantage than the dried specimens. Many plants may be photographed in the woods and fields, but until you attempt this you will not realize how many drafts and breezes are constantly moving the delicate leaves and flowers. Even on the calmest days and in the most sheltered spots you will find it difficult to secure a time exposure of growing plants, but by using patience, and if necessary placing a folding screen about the plants, very beautiful pictures may be obtained. If a plain, tinted or black card is placed behind the plant for a background the pictures will be far more satisfactory, for a confused mass of twigs, foliage, grass, or ground makes a very poor background, even if it is softened by being out of focus. Be sure to place the card far enough away so that no shadow is cast and do not attempt to take pictures where the brilliant sun strikes the plants in spots and blotches. In the open, plants may be photographed in bright sunlight—although a diffused light, such as is found on a slightly cloudy day gives better results—but in the woods or among foliage the direct sunlight should be screened from the plant by some object held above it while the exposure is being made.

Many wild plants and flowers are so delicate or wilt so soon that in order to secure good pictures the photographs *must* be made of the living, growing plant. There are many other species which may be photographed to far better advantage in the house or studio, however. These may be placed in bottles, vases, or on stands and photographed with the camera placed horizontally, but far better results may be obtained by placing the camera vertically. For this purpose you must make a strong, rigid stand, with an upright to support the camera, and the flowers or other objects are then placed upon a horizontal stand or support below the camera. To get the best effects the objects to be photographed should be arranged upon a sheet of clean glass which is supported at some distance above a background of paper or cardboard of the desired shade. This obviates any shadows and brings the flowers into strong relief and by placing the stand between two windows very beautiful, even lighting may be secured.

When photographing flowers or plants use orthochromatic plates if it is possible. A red, yellow, or orange flower photographed with an ordinary plate will appear nearly black, while the deli-

cate veins and details of a pale-blue or purple flower may be entirely lost in the glaring white spot which represents it on the finished print.

Orthochromatic plates give far better effects of true color-values and as the beauty of flower photographs depends upon the accuracy with which each and every detail and marking is shown you should use every effort to reproduce these in your pictures.

When making the prints from negatives of flowers, insects, birds, animals, or any other nature photographs use black and white matt-surface paper. Developing papers, such as Velox, Cyko, etc., are far better than the gold or silver printing-out papers, but even these are far less to be advised than the real platinum papers. Properly made platinum prints are absolutely permanent and exposure to sunlight or to atmosphere does not affect them, but any printing-out paper is liable to fade and the developing papers often become discolored with age. Moreover, a platinum print may be colored with water colors and will be as delicate and dainty as an original water-color drawing. The developing or printing-out papers *can* be colored, but the results are seldom very satisfactory and the work is difficult.

No matter what class of natural objects you photograph use care in numbering and labeling the negatives and prints. You may be able to remember all about them for a time, but you cannot depend upon your memory as the pictures accumulate, and the only sure method is to number and catalogue each plate and label the prints. A collection of nature photographs without labels or data may be very pretty and interesting but from a collector's point of view, or scientifically, it will be practically worthless.

CHAPTER IX

THE USE AND VALUE OF THE MICROSCOPE

ANY boy will find a good miscroscope a very interesting instrument and to the boy collector a microscope will be of the greatest help and value, aside from the many interesting things you can learn by its use.

By using a microscope many living creatures may be seen and studied which are nearly or quite invisible to the naked eye, while many larger things will reveal new wonders and undreamed of beauties. Very good instruments can be purchased for a few dollars and for ordinary purposes a cheap microscope will answer just as well as a very expensive affair. To prepare sections, mount slides, and make dissections and preparations for serious microscopic study is an art in itself, and is not within the scope of a book on collecting. A great deal may be learned, a vast number of interesting things discovered, and an added attraction will be given to your specimens by simple microscopy and without

the trouble or bother of the more difficult and intricate details of sections, slides, etc. Some specimens must be mounted on slides in order to study them, but a great many can be watched while they are alive and many more may be placed temporarily on dry, unprepared slides and the slides may then be used over and over again.

Aside from the microscope itself you will require a few glass slides, some slide-cover-glasses, some Canada balsam and glycerin jelly, some asphaltum varnish, some watch-crystals and some fine forceps, a needle in a handle and some small camel's hair brushes. The same forceps and needle-point which are described for the insect collector may be used in microscopic work and the other things may all be purchased very cheaply. The watch-crystals are used when living creatures are to be examined, while the slides may be used plain for dry objects, and other specimens may be mounted under the cover-glasses for preservation and as permanent slides.

In order to mount an object it should first be preserved with alcohol or formaldehyde solution. A drop of balsam should then be placed on a clean slide, the slide should be warmed until the balsam

spreads and is softened, the object to be mounted should be placed in the balsam, and a cover-glass pressed gently, but firmly, over all. When the balsam hardens a narrow ring of asphalt should be painted around the edge of the cover-glass and the slide will be finished. Sometimes little bubbles of air will form in the balsam, but this may be remedied by heating the slide slightly before cementing with the asphalt and after a little practise you will learn how to press out the air by the cover-glass, as well as just how much balsam to use and how much to heat it.

Glycerin jelly is used for the same purpose as the balsam and for some specimens one is preferable and for other objects the other. Many objects may be mounted dry, by painting a ring on the slide, arranging the specimens within it, placing a cover-glass over it and painting asphalt around the edges. This method is excellent for such specimens as the scales from insects' wings, minute shells, sand, pollen from flowers, and similar things.

To use the microscope, place the instrument in a good light, place the slide with the specimens on the stage or carrier, turn the reflecting mirror until it casts a clear, bright light through the slide

and then adjust the barrel of the microscope containing the lenses up or down until the objects on the slide are clear and sharp. In the case of opaque or solid objects the light should be thrown upon them from above and for this purpose a bull's-eye or condensing-lens on a stand should be used, or a small pocket-mirror may be arranged upon a support to accomplish the same result.

All but the very cheapest microscopes are provided with several objectives or lenses of various powers and the lens to be used depends a very great deal upon the specimens being examined. It is just as much a mistake to use a lens which is too powerful as to use one which is not powerful enough. The high-power lenses have but little depth of focus—except those of the most expensive grades —and hence the entire specimen cannot be brought into focus at one time if it has any appreciable thickness. On the other hand a low-power lens should not be used on very minute objects; a specimen which appears as a mere meaningless dot through a low-power lens may be marvelously beautiful and very distinct through a lens of higher power. Bear in mind that the lower the power of the lens the farther it should be from the slide and

vice versa. Never screw the lens down against the slide—it will ruin the slide and may injure the lens—and unless you use a lens of extreme high power there should always be quite a little space between the object and the lens. One advantage of the microscope is that you do not have to go far or search long for specimens to study. A drop of common pond or lake water in a watch-glass, a pinch of dust from the room, a few grains of sand from the seashore, a little down from a butterfly's wings, some powdered chalk, a tiny piece clipped from a feather, or the wing, leg or antennæ of a fly or other insect, are all good subjects for the beginner with a miscroscope.

You will be surprised to find the apparently clear drop of water filled with strange and beautiful forms of living creatures moving rapidly to and fro, the specks of dust will resolve themselves into a myriad different objects, the grains of sand will appear as magnificent crystals and flashing gems, the down from the butterfly's wing will prove to be gorgeously colored and beautifully formed scales and feathers (Fig. 1); instead of the powdery chalk you will see a host of delicate, fairy-like shells, and the portions of the insects' anatomy will appear like

the remains of some prehistoric monster. A boy may spend hours or days studying a common fly or mosquito through a microscope and until he has done this he can obtain but a very poor idea of the details of the structure of insects. The antennæ, jaws, and other portions of a fly, or any other insect, are extremely complicated, but are perfectly

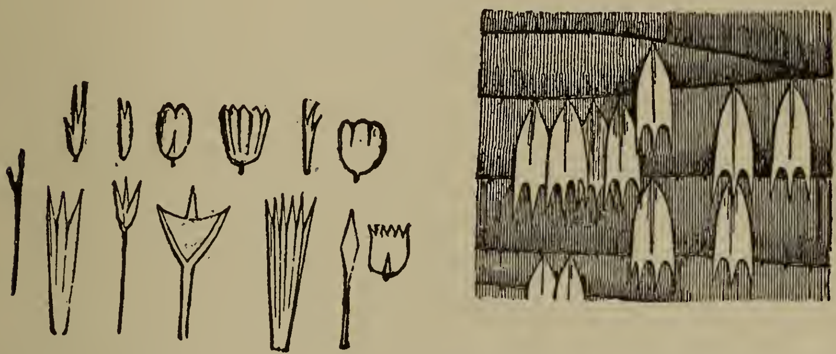

FIG. 1. Scales of a butterfly's wing as seen through the microscope

designed for the duties they perform. Such a specimen as a fly's palpi, or jaw, viewed through the miscroscope will do more to increase your appreciation of nature's marvels than hundreds of prepared insects in a collection, or pages of printed descriptions in books (Fig. 2).

Microscopes are very useful for commercial and industrial purposes and you can obtain a lot of fun and will find a great deal of interest in trying to

analyze various common substances with your microscope. Flour, starch, spices, fabrics, and in fact any other substance or material, when examined through these useful instruments, will usually be found full of foreign substances, adulterants, and strange odds and ends. As an example of the value of the microscope in determining the composition of any certain material, glance at Fig. 3. This looks like a pile of good-sized sea-shells, such as you might find upon a wave-washed shore. In reality it is a pinch of sand from the shore of Bermuda and proves beyond question that the so-called "coral sand" of those islands is really composed almost entirely of minute shells, although to the naked eye it may seem as fine as flour and the grains may have no definite form. After you have studied various objects through the microscope you will no doubt wish that you could reproduce what you see for the benefit of others and as records of the wonders which you have discovered. This may be readily accomplished, for you may draw or photograph through the microscope and thus produce perfect facsimiles of the objects as you view them through the lens.

In order to draw through the microscope you will

require a camera lucida which is an inexpensive affair that fits over the eye-piece of the microscope. The camera lucida consists of a triangular piece of glass, or prism—or a piece of tinted glass—set at an angle so that the image of the specimen under the lens is visible by its reflection on the prism. The microscope, with the camera attached, is placed with the barrel in a horizontal position and a sheet of paper is placed directly under the camera lucida. By looking into the attachment with one eye you will see the enlarged specimen under the lens apparently outlined upon the paper. By adjusting the lenses out or in and by raising or lowering the paper the outlines will become sharp and distinct. If you now take a pencil you will be able to follow, or trace over, the image projected upon the paper and will thus be able to make a perfect drawing of the object under the lens. You will no doubt have a little trouble at first, for you must learn to keep your eyes in the same position and must not attempt to see either the image or the tip of your pencil too plainly. With a little practise, however, you will find that it is a very easy matter to make drawings in this way. Do not attempt to shade, color, or ink the drawing under the camera—just

make the outline and draw in the various details and then finish the drawing by free hand while examining the object through the microscope in the ordinary manner as you proceed. It is a good plan to commence drawing fairly large, simple things through a lens of low power and as you become accustomed to the work and acquire skill you can attempt more intricate and complicated specimens under higher powers. It is by this method that the beautiful drawings of microscopic objects are made for scientific works. The accompanying illustration shows three examples of camera-lucida drawings; Fig. 4 represents the antennæ of a number of common insects, Fig. 5 the feet of flies, water beetles, etc., and Fig. 6 a section of a horse's skin showing the roots of hairs, sweatducts, and similar details.

To make photographs through a microscope, or as they are more properly called, "photomicrographs," is more difficult than to make camera-lucida drawings, but the results are even more satisfactory.

There are several methods of making photomicrographs, but for most purposes the simplest and easiest method will be found the most satisfactory,

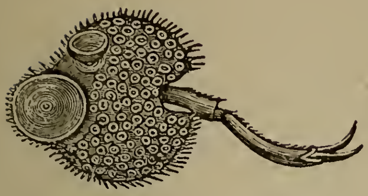

FIG. 4

FIG. 5

FIG. 6

FIG. 4. Antennæ of insects drawn through the camera lucida. FIG. 5. Feet of flies and beetles drawn through the camera lucida. FIG. 6. Section of a horse's skin drawn through the camera lucida

especially for beginners and with low-power lenses. This consists of fitting an ordinary long-draw camera with a tube or sleeve of light-proof black cloth at the front end. The eye piece is removed from the microscope, the dark cloth is connected with the barrel of the microscope, the latter is focussed until the image of the specimen on the slide stands out sharp and distinct upon the ground-glass of the camera and the exposure is made. This sounds very simple, but there are a number of details which must be attended to which make the work somewhat difficult. In the first place ordinary daylight will seldom be strong enough to use in making these greatly magnified photographs, and artificial light must be used. An incandescent lamp, a Rochester oil lamp, or a Welsbach mantel gaslight will usually serve this purpose and the results will be better if a powerful reflector or a mirror is placed behind the light. If you have a good stereopticon or magic lantern this can be used to throw a powerful light upon the microscope slide and the electric or acetylene headlight of an automobile also makes a splendid light for this purpose. Some of my most successful photographs through a microscope were taken by means of an acetylene bicycle lamp

and as such lamps give a very white, steady, strong light they are excellent for this use. Of course when using the microscope with a camera in this way the microscope barrel must be placed horizontally and you may find difficulty in getting the object focussed sharply upon the ground glass. Try focussing first with the microscope barrel alone and then move the camera out and in until the image shows clearly. Even then you cannot be sure that it is in really sharp focus, for the microscope lens has little depth of focus and the variation of a small fraction of an inch may result in a blurred picture. To insure very clear focussing the ground glass should be rubbed over with vaseline, or some sort of grease, to make it more transparent. This need not cover the entire glass for a small spot is sufficient on which to focus the object. Many operators use a piece of clear glass and use a hand-lens for examining the image thrown on the glass and where high-power lenses are used on the microscope this is an excellent plan. Finally there is the question of exposure. This varies so greatly with different specimens, different lenses, and different lights that it is impossible to give any good idea of what exposure should be allowed, but

usually fifteen minutes to half an hour is none too long. The best way is to try one plate, with say ten minutes' exposure. If this shows under-exposure or over-exposure you can then judge of the proper amount to increase or decrease the time given. It is wiser to over-expose than to under-expose, however, for sharp, dense negatives are desirable and over-exposed plates treated with a slow, intense developer—such as hydrochinon and bromide of potassium—give better results than under-exposed plates with a developer which gives thin negatives with lots of detail. Different makes of microscopes have different arrangements of their lenses and with some instruments it is impossible to secure good photographs as described. In such cases try leaving the regular eye-piece in the microscope and attach the camera as directed. With some instruments the lens may be removed from the camera and the microscope lens may be used by itself, but this is frequently impractical, although very beautiful pictures may be taken in this way. The best way to determine the proper method to follow in order to secure satisfactory results is to try various combinations of camera and microscope and persevere until you are successful. In

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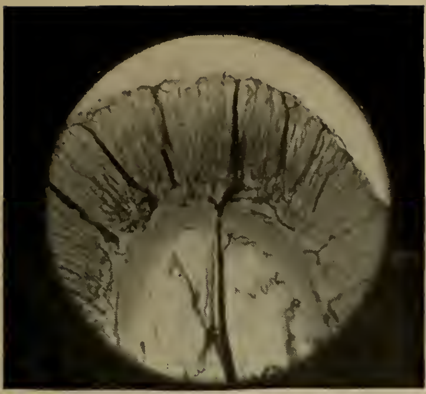

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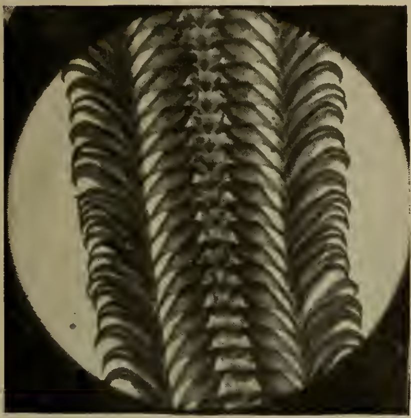

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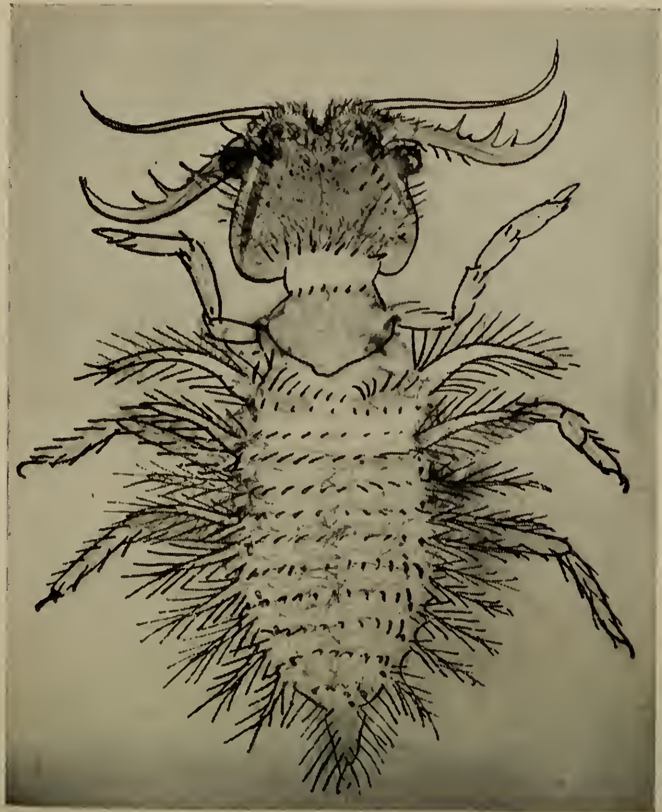
11

3

Photographs Made Through a Microscope

(See Chapter IX)

12



2

Photomicrographs of Insects

(*See Chapter IX*)

the illustration several examples of photomicrographs are shown and you can see by these what excellent and very interesting results may be obtained. Fig. 7 is a photograph of a section of the lining of a cat's stomach, Fig. 8 shows crystals of Cinchonidine, which is the active principle in Peruvian bark, Fig. 9 is the tongue of a small marine shell, and Fig. 10 is the head of a tiny insect which is about the size of the common plant-lice and is known as an "Aphis Lion" from the fact that it devours the troublesome aphids.

Although true photomicrographs are so interesting there are a great many small things which can be photographed in greatly magnified form without the microscope. If you have a long bellows camera you can photograph such objects and enlarge them several times and by attaching a box or tube to the rear of the camera to further lengthen the draw, or by placing one camera behind another (with the ground glass of the first and the lens of the second removed) you can make still more highly magnified pictures. But to make photographs which approach photomicrographs in the amount of their enlargement an exceedingly long draw is necessary which makes the camera very bulky and clumsy.

This may readily be overcome by using a very short-focus lens on a long-bellows camera and if the lens is of good quality photographs may be made in a camera of three foot draw which are sharp and clear and are almost as greatly magnified as those taken through a microscope with low-power lenses. The photographs of a dandelion seed-head (Fig. 11) and of the Aphis Lion (Fig. 12) were taken in this way. After you have photographed a few specimens by these methods and see the beautiful and surprising results you obtain you will have an increased interest in collecting and will find a new world opened to you by the microscope and camera.

PART III

COLLECTIONS OF MAN-MADE OBJECTS

CHAPTER X

INDIAN RELICS

FEW objects made by man have a greater interest and fascination for boys than Indian relics and few are more worthy of being collected. Indian relics of one sort or another are found in nearly every part of America and collections of aboriginal weapons, utensils, ornaments, and handiwork are of great value and serve to teach us much about the life and customs of the early inhabitants of our country.

While great numbers of pure-blooded Indians still survive and some may be found in nearly every State of the Union, yet many tribes have disappeared entirely and many others are decreasing in numbers each year. Moreover, with few exceptions the Indians of to-day are rapidly acquiring the life, habits, dress, and arts of the white man, and it is only a question of time when Indian handiwork will be a thing of the past.

For these reasons the collection of Indian relics

should not be confined to stone arrowheads and other ancient or prehistoric objects but should include articles of every sort made or used by Indians, or Eskimos, and which savor of primitive or savage man.

In a general way all Indian relics may be divided into two groups: ancient relics and modern relics. In the first class are stone weapons, ancient pottery, utensils, tools, ornaments, wampum, and in fact any objects which are found in mounds, graves, shell heaps, or other situations and which antedate the settlement of America by Europeans. In the other class are included buckskin articles, beadwork, baskets, pottery, weapons, utensils, and in fact anything made by Indians within comparatively recent times, or which is in use by Indians to-day. There is no real place to draw the line between ancient and modern relics, however, for a great many of our native tribes used stone weapons, identical with those found in ancient mounds, until quite recently and some isolated and primitive tribes still make and use various articles which might properly be classed as "ancient." Moreover, prehistoric tribes no doubt used baskets, leather articles, and similar things which may have been identical with those

used by their descendants of the present time. In some ways these modern relics are even more important than the ancient ones, for the latter will continue to exist for ages to come, whereas buckskin and beadwork will soon disappear, if not preserved and protected in collections.

Really good buckskin articles and beadwork are even now difficult to obtain and each year they are becoming scarcer. Of course there are quantities of bead-embroidered objects for sale in stores, Indian camps, and other places and while some of this is fit for collections a great deal is only made to sell to tourists. This class of "Indian" goods is often manufactured in shops or factories and is purely imitation or counterfeit, but quite a lot is made by real Indians. Although far inferior to the goods made by the redmen for their own use such objects are much better than nothing at all, for they often exhibit the tribal or individual designs and patterns of the Indians and illustrate the forms and styles of articles used by them.

In the old days, and until they became civilized to large extent, the Indians used beautifully soft-tanned leather, did their sewing with thongs, roots, and sinews and dyed their feathers, porcupine-

quills, and ornaments with berries, vegetable-colors, and ochers. To-day they have learned that sheepskin, kid, chamois, and other commercial leathers are cheaper than buckskin or elkhide, that aniline dyes are brighter and are easier to prepare than vegetable dyes, and that cheap cotton thread is easier to use than sinews. The beautiful bead-work, formed by sewing each bead separately to the buckskin, has largely given place to beads strung and woven on hand looms and afterwards sewed to leather or cloth, and silk embroidery floss often serves in place of porcupine quills.

Oftentimes these up-to-date Indian goods make valuable and interesting specimens, for they serve to show the influence of the white man and his civilization upon the native arts and industries.

Originally the patterns or designs on Indian ornamental work really had a meaning and the totem, or sign, of each tribe, family, and individual was often wrought into moccasins, vests, leggins, head dresses, etc. Sometimes the Indians still retain such symbols and employ designs with definite meanings, even in their cheapest and most tawdry work, but in a great many cases they merely use

the designs which are brightest and most attractive to the white visitors to their camps.

To a person familiar with Indian life and traditions each design, ornament, and decoration tells a story, and an Indian or plainsman can tell the tribe to which an Indian belongs by the moccasins, feathers, or ornaments which he wears. Many tribes still make and use various articles which are distinctive and are scarcely affected by the white man's influence, while others have practically forgotten and discarded everything savoring of savage life or customs. Still other tribes are in a sort of transition period, in which their handiwork is a curious combination of the aboriginal and the civilized and the collector should aim to have specimens of all these in order to show the gradual transition of the Indians from a savage to a civilized race. Don't discard or pass by an Indian or Eskimo article merely because civilized materials are used in making it. Oftentimes the most primitive and isolated tribes combine the products of the white men with natural objects in a most curious manner. South and Central American tribes often string shoe-buttons, safety pins, brass clock-wheels, sealing wax, and pieces of glass side by side with jaguar

and monkey teeth, while other tribes make beautiful arrow-points from old beer bottles!

Indians appreciate the utility of civilized things and the more uncivilized and primitive they are the more they prize objects of metal, cloth, etc., which they can obtain from white men. Even in the earliest days of the American settlers the Indians adopted hatchets and axes as tomahawks in place of their stone-headed weapons, and bows and arrows soon gave way to firearms, but this doesn't prevent iron-headed tomahawks or flint-locks or other guns from being interesting specimens in the collection of Indian relics. A shingling-hatchet, with a buckskin-covered, ornamented handle (Fig. 1), is just as interesting for the collection as a stone-headed "skull cracker" (Fig. 2), and a gun with stock scratched and ornamented by the Indian owner (Fig. 3) is just as truly an Indian relic as a bow and arrows in a buckskin case (Fig. 4). A great many of the Indian relics which the collector secures will be of value or interest solely as examples of savage handiwork and customs, but now and then you may obtain articles with true historical or romantic value. A plain, horn-handled hunting-knife with badly rusted blade may not appear

of great interest, but if the label shows that it was found embedded in the breast of an Indian's skeleton it at once becomes a valuable relic. An Indian friend once gave me a beaded headband which belonged to Sitting Bull. At first sight this seemed a very simple bit of buckskin covered with splendid

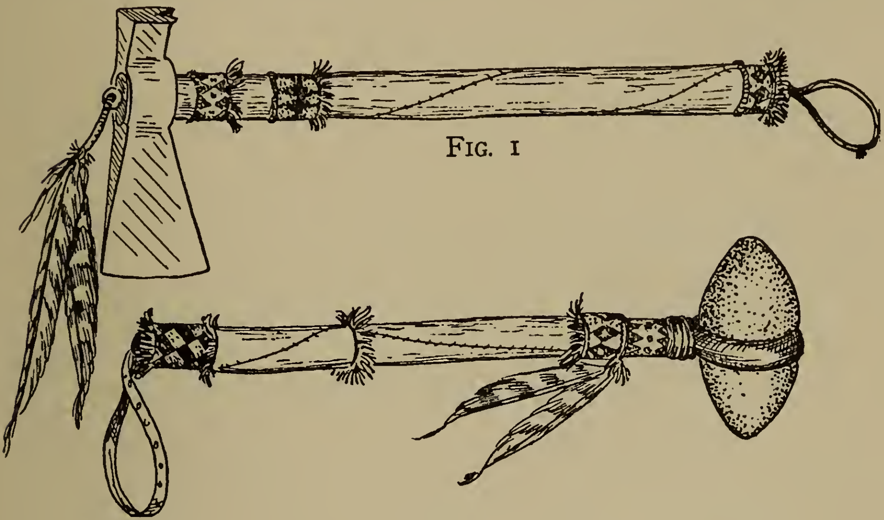


FIG. 1

FIG. 2

FIG. 1. Tomahawk made from old hatchet. FIG. 2. Stone-headed skull cracker

beadwork, but when worn by my wife in the presence of Sioux Indians it invariably aroused their interest and curiosity and proved an easy and certain means of winning their confidence and friendship as soon as they learned the history of this relic of their great Medicine Chief.

Baskets are also valuable specimens for the collection, for each tribe has baskets of a distinct style and pattern and while many tribes now weave baskets according to white men's ideas and for department and ten-cent stores, yet they have not for-

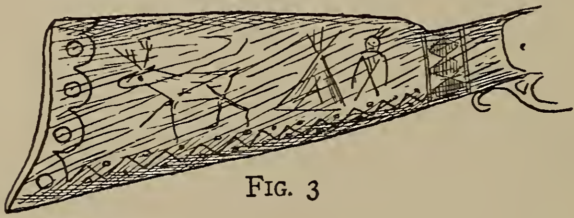


FIG. 3

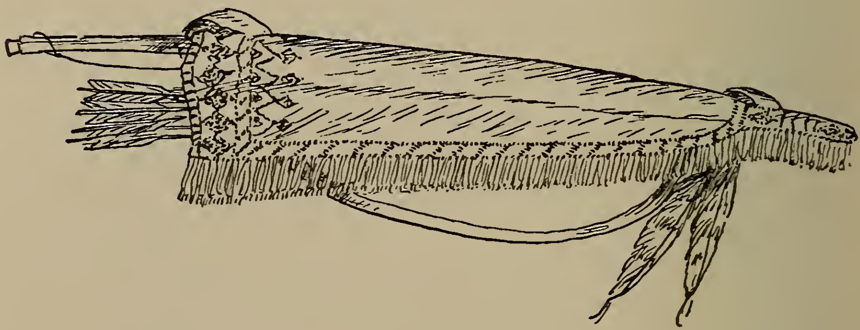


FIG. 4

FIG. 3. A gun stock ornamented by Indians. FIG. 4. Bow and arrows in buckskin quiver

gotten how to make their own individual forms and patterns. There is a wide difference between the sweet-grass baskets of the eastern Indians and the wonderfully beautiful affairs of the Zuni and Californian tribes, and every collector should strive to secure a typical series of Indian baskets for his

collection. Some few tribes are noted for their skill in weaving, others for their pottery, others for their metal work, others for beadwork, and still others for their handiwork in horsehair, grass, etc. A small Navajo blanket, Pueblo silver and rough turquoise ornaments, Sioux and Ojibway embroidery, and similar specimens of the arts and crafts typical of each tribe should be represented in the collection. If you live near a reservation, camp, or tribe of Indians you can usually obtain a great many specimens and duplicates may be traded or exchanged with other collectors for examples of the handiwork of other tribes. If you travel about you can obtain specimens from various localities and tribes and if you do not either travel or live within reach of an Indian settlement you will have to depend upon purchasing specimens or upon exchanging other specimens for them. Ancient Indian relics are found in nearly every part of the country and these may often be traded for modern objects to advantage.

In some ways the ancient relics are even more interesting than the modern objects, for they tell the story of the Indian as he was before Europeans landed upon this continent and forced the redman

from his native woods and plains. In some parts of the United States stone implements are very abundant and thousands of arrow- and spear-heads may be easily secured, whereas in other places they are so rare that a collector feels well rewarded when he secures a single specimen. In quality, form, and material these ancient relics vary as greatly as in their abundance. In one district they may be crudely made of hornstone or jasper, in another they may be of pure white quartz and very beautifully formed, in still another place they may be of volcanic glass or obsidian, while in still another locality tiny bird-points of agate may predominate.

As these implements were all chipped by hand from the rocks or stones of the neighborhood it is seldom that those found in any two places are similar and for that matter no two stone implements are ever exactly alike. For this reason duplicates may be said never to exist, but in reality there are many so nearly alike that is not necessary to retain them all. Such specimens may be readily exchanged with collectors in other parts of the country and in this way an excellent collection may be formed. The boy in Oregon, with his assortment of agate

bird-points will be able to exchange his duplicates or superfluous specimens with the boy in the East who has only crude, rough relics from the shell heaps of the Atlantic coast and the boy in the Middle West can obtain obsidian weapons in exchange for the stone objects found in the graves of the mound builders.

I have mentioned that the stone implements were made locally from the material close at hand and while this is quite true, yet one often finds relics of forms or materials which proves that they came from some far distant part of the country. This is due to the fact that even in the earliest times the Indians often traveled for long distances on their hunts, war trails, or pilgrimages and they also traded with other tribes. In some parts of the country the natives had no suitable material from which to form their tools and weapons and to obtain this they traded other things which existed only in their neighborhood. Thus the red pipestone of the upper Mississippi Valley was highly prized by the Indians and formed a standard medium of exchange throughout the country. Certain shells and other objects, found upon the Atlantic coast, were valued by the western Indians,

while the curious "tusk shells" and abalones of the Pacific shores passed from tribe to tribe and were used as ornaments by Indians who had never seen salt water. It doubtless required years for some of these objects to pass from hand to hand until at last they were buried with their owner in spots hundreds or thousands of miles from where they originally occurred and the collection of relics from one locality will often throw a great light upon the intercourse that existed between widely separated tribes.

Another important part of the collection is pottery. Nearly every Indian tribe made pottery of some sort and the quality of their pottery is a pretty good indication of their advancement along the path toward civilization and peaceful lives. Nomadic, war-like tribes were seldom long enough in one spot to bother with the art of making pottery, while those tribes which lived in permanent camps or settlements found pottery useful and convenient and advanced rapidly in the art of molding and baking clay into utensils and dishes. In the North and East pottery is comparatively rare and it is seldom that a perfect piece is found, whereas in the Middle West it is quite common and in the South-

west, in Mexico, and in Central America it occurs in vast quantities.

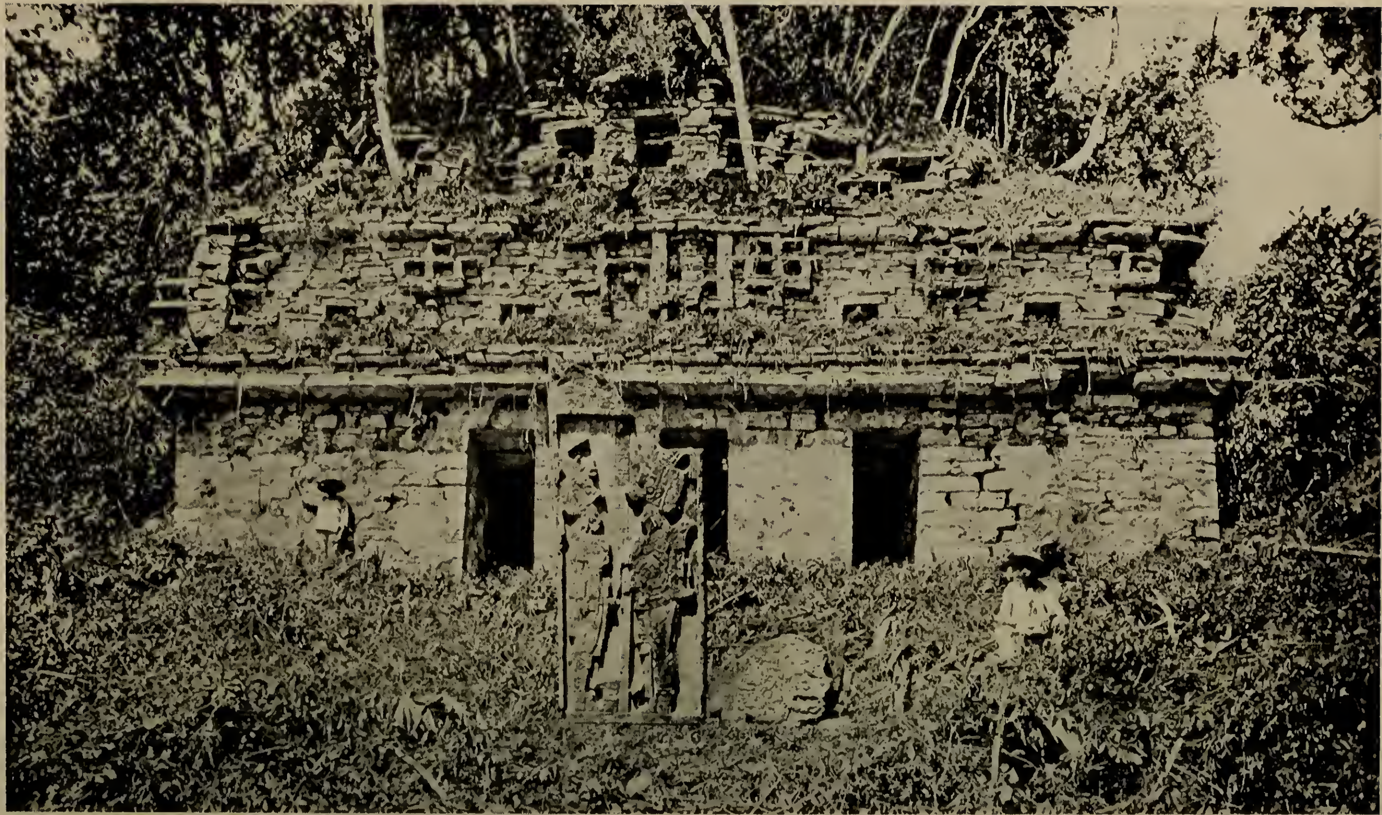
Never discard a bit of broken pottery—even fragments are worth saving—and quite frequently a very fine specimen may be obtained by carefully matching a number of pieces and restoring the original vessel. In some parts of the country there are carved rocks, ancient ruins, mounds, etc., which are of vast interest, but it is seldom that such things can be included in a collection. Photographs often show such objects very well and whenever a carving, a mound, or a ruin is discovered you should take a good picture of it and include it in your collection (Fig. 5).

If the figures cut in the rocks or cliffs are very lightly carved or show little contrast with the surroundings they may be brought into relief by rubbing light-colored clay over the surface, but after the pictures are taken this should be carefully removed. In some cases a mold of plaster or clay may be made and the carvings may then be reproduced in plaster for the collection. When a grave or mound is found it should be photographed and carefully measured and a diagram or map should be made. If the grave or mound is opened you

should use great care to note exactly how it is formed and the relative positions of everything it contains should be described in a note-book, as these are of great importance and value. When an Indian mound or grave is opened it will almost always yield a fine assortment of specimens, for the natives usually buried the bodies of their fellows with all their personal belongings. In former times vast numbers of these graves and mounds were opened for the objects they contained and with no regard for the importance they might have. Much which might have been discovered was thus lost forever and nowadays most of the large and important mounds are under state or federal protection. In addition to these there are numbers of individual graves, as well as many small mounds, which have never been discovered or opened and which any one may explore. If these are excavated properly and with due attention to their form, arrangements, measurements, etc., you will be aiding instead of hindering archeological research and your notes may be of great interest and of immense educational value; and in addition the specimens obtained will be of much greater interest than if they were dug out without noting the surroundings. Along

5—Indian Carvings on Rock

(*See Chapter X*)



Good Photographs of Prehistoric Ruins Are Valuable for the Collection

(*See Chapter X*)

the seacoasts, where Indians once lived, you may often find great piles of sea shells. Sometimes these cover large areas and form miniature hills, while in other localities they are mixed with earth, overgrown with grass and brush, and show as layers in the banks exposed by washouts, storms, or cuttings.

These are known as "shell-heaps" or "kitchen-middens" and mark the spots where Indians once camped and for long periods lived upon the shell-fish of the vicinity. As these shell-heaps were being formed the Indians lost or mislaid numerous implements, weapons, etc., just as the modern kitchen and table utensils are often thrown into the garbage pail. While it is practically impossible to search these old refuse piles thoroughly, yet after heavy rains or storms you may frequently secure good specimens of arrow-heads, knives, axes and hammers, bits of pottery, etc., among the material washed from the banks or heaps and many hours or even days may be profitably spent searching through kitchen-middens. In some localities, where the seaside banks have been storm beaten for long periods, you will find arrow-heads and other stone implements upon the beaches among the peb-

bles. Usually such specimens are badly wave-worn and are of little value for collections, but I know of one spot where a person can always pick up a few excellent specimens after every storm. In this case, however, the relics do not come from shell-heaps, but from the odds and ends thrown out by some arrow-maker who camped there in ancient times. This is proved by the fact that a great many of the implements are only half finished. The maker, having evidently found they were not chipping true and even, no doubt discarded these partly finished objects, but for the collector they are very valuable for they illustrate the various stages in the process of the manufacture of stone implements. Among the other objects found in this spot are countless chips and flakes of stone, while a near-by vein of quartz shows the spot from which the primitive artisan obtained his material. If you find such a place as I have described be sure to keep specimens of the chips, for these, displayed with the partly finished and completed implements, make an interesting exhibit. Another arrow-maker's camp-site which I once found was on a tiny dry rise or "island" in the middle of a vast salt marsh. The little spot of dry ground was not over a dozen

yards in diameter and was covered with a tangle of weeds and a few stunted trees. A few chips of white quartz and some bleached and decayed clam shells attracted my attention and in a few hours' time I secured nearly one hundred arrow and spear heads, several of which were absolutely perfect. In other places freshly plowed fields often reveal many Indian relics, especially if they happen to be spots where an Indian battle was once fought, or where Indians were once buried, and some of the finest specimens I have ever found were discovered lying exposed upon the surface of the earth where the sod had been turned up by the plow. Sometimes the story of a battle between the Indians and Europeans will be revealed by the farmer's plow and harrow and with the stone weapons of the savages will be found the remnants of old guns and pistols, sword-hilts, bullets and buttons which have lain hidden and forgotten for several hundred years. Many of the Indian camps were beside rivers, ponds, lakes, and brooks and at times you may find pottery, stone implements, mortar-pestles, and other objects among the stones in the beds of streams. In fact, Indian relics are liable to be found in almost any situation and they often bob up in the

most curious and unlikely spots. I have found them in the gravel and sand dug from city streets by men laying a sewer-line, I have picked them up on open roads and paths, and the most beautiful white-quartz arrow head I ever obtained was lying upon a railway tie between the rails!

In arranging and classifying your collection of Indian relics you should use just as much care as for any other specimen and should arrange the objects by some sort of definite system. This may be by tribes, by localities, or by the class of relics, but the best method is to combine these by arranging the ancient things according to States and the modern relics by tribes and at the same time keeping all the articles of a similar nature together.

One great advantage of the Indian relic collection is that very little care or preparation of the specimens is required. Stone implements are not injured by exposure to light, dust, or air; an object which will endure the elements for centuries is not easily injured or broken. Pottery, however, is often very frail and should be carefully protected and all objects made of leather, feathers, hair, or other animal matter, as well as baskets, blankets, etc., should be placed in moth-proof cases

with some substance, such as naphthalene or camphor, to prevent the ravages of insects. Small stone relics, such as arrow and spear heads, may be conveniently kept upon cards to which the specimens should be attached by means of fine wires

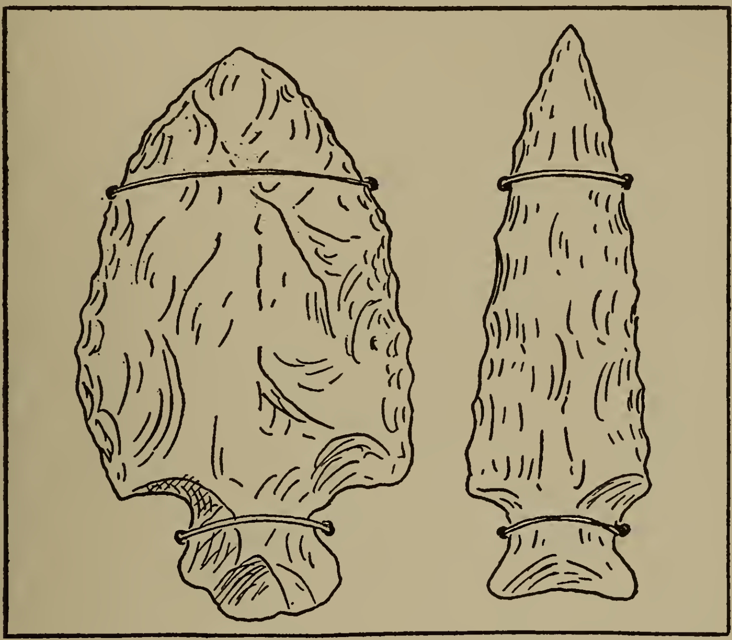


FIG. 6. Arrow heads should be mounted on cards by means of fine wires.

passed through holes in the mount, as shown in Fig. 6. Large stone implements may be placed in trays or drawers or laid upon shelves, but pottery, clay utensils, beads, wampum, and other delicate objects should be placed in boxes with glass covers

and if very fragile they should be surrounded by cotton. Each object should be numbered and catalogued, the number being painted or written upon the specimen itself or upon a small label glued to the article, and in addition a regular label should be provided for every relic. You may at times find it difficult to identify or classify your specimens. Arrow, spear, and hatchet heads, mortar-pestles, mortars, axes, hammers, beads, and many other objects are unmistakable, but there are many other relics which are of such doubtful character or of such unusual forms that you cannot even guess their use. Even experienced experts in relics of the Indians are frequently at a loss to classify such objects and a great many of them have been named wholly on supposition. No doubt the aborigines knew perfectly well what each article was intended for, but modern man finds it mighty hard to tell with certainty whether a rough, sharp-edged bit of stone was used for a knife or a chisel, or whether a rudely formed, rounded rock was designed for a hammer or a war-club. Many stone implements are perforated and were no doubt hung on strings or thongs, but whether these were worn as amulets, charms, or ornaments, or were merely hung upon

a string so they would be handy and would not become mislaid, is often purely a matter of personal judgment and opinion upon the part of the archeologists. Some relics are obviously ornaments, for they are found with beads and resting upon the breasts of skeletons, but others are found loose among many other relics. Sometimes, too, it is hard to distinguish between real relics and rough, worn, or broken stones which have never been used by man. The evolution from the rounded cobble to the beautifully finished maul was gradual, as was the progress from a chip of flint or quartz to the finest spear and arrow heads. The earliest savages merely selected the bits of rock that they picked up here and there and used these for their tools and weapons. In time these prehistoric men discovered that certain forms of rocks were better adapted to specific uses than were others and gradually they learned to improve upon the natural stones by breaking or chipping them into the shapes they desired. Of course their first attempts were very crude and hence there must have been every grade of implement and weapon and if you are doubtful whether a certain rock is a real relic or not, keep it anyway. As a rule relics, even if they were origi-

nally natural rocks, will show signs of wear or of chipping or hammering and it is far wiser to include a natural stone that resembles a relic than to throw away a true relic merely because it appears too crude or clumsy to have been formed by man. There are many books on Indian relics and in nearly every museum there are extensive collections and by comparing your specimens with the descriptions and figures or with the other specimens, you can usually identify them. When these methods fail, send a photograph, sketch and description to some archeologist and enclose stamps for a reply. Such experts can usually identify the specimens and will be glad to help you and if the specimen is unique, rare, or unusual you may be able to exchange it for a number of other specimens of far greater interest and value to yourself.

CHAPTER XI

WAR, HISTORICAL, AND OTHER RELICS

THE stone relics of the ancient Indians, and the more modern articles of buckskin and feathers, bring to one's mind the exciting days when red and white men battled and warred over the new world. Now and then an ancient firearm, a corroded button, or some similar relic is found beside the crude weapons of the savages and it is quite fitting and appropriate for boys to collect relics of our ancestors, especially those which are associated with the Indian wars and the conquest of America. Such things are becoming scarcer each year, for museums, collectors, and dealers have searched far and wide for them and only once in a great while can the amateur obtain good specimens at first hand. But more than half the fun of collecting consists of hunting for specimens and in old farmhouses, garrets, ancient trunks, junk shops, pawnbrokers', and antique stores many war relics may be obtained for a trifle. If you collect war

relics you may confine yourself to one class of relics, such as firearms, or you may include everything which was used in warfare, such as knapsacks, buttons, flags, bayonets, swords, armor, bullets, uniforms, etc. You may make a specialty of the objects associated with one particular war and collect Revolutionary War relics or Civil War relics or you may collect anything and everything that comes along—from bits of rusty armor used by the Spanish conquistadores to the shells of the latest Mausers used by Germany—but which ever you do you must not expect to obtain a good collection unless you buy or exchange, for most of these things have a definite market value and can neither be picked up along the seashore like shells, nor chipped from rocks and cliffs like specimens of minerals and fossils. Of course there are exceptions to this. In Mexico, Central America, South America, Florida, and some of the West Indies ancient Spanish armor, old Toledo blades, helmets, guns and pistols, cannon balls, halberds, and cross bows are often found in the old forts and castles, in forgotten graves, or buried where they fell with the stone weapons of Indians beside them. In many of the countries mentioned the days of mail-clad knights,

plate-laden galleons and bloody freebooters are closely linked with the present and one may step from a palatial steamship or an electric-lighted, motor-crowded street into buildings and scenes contemporaneous with Cortez, Pizarro, or even Christopher Columbus himself. In some places traditions furnish a guide to the seeker after ancient war relics and by delving among the ruins of cities destroyed by earthquakes centuries ago the searcher may find rusty armor, gold and silver coins, beautifully wrought weapons, and numerous other objects; but in most places the relics, if found at all, are discovered by accident and in unexpected places. Once, when digging in a sand bank on a tiny Bermudian island in search of fossil shells, I unearthed two human skeletons. Most of the bones had long since been washed away and destroyed, but among the bleached bones still remaining were fragments of cloth and several buttons. These proved to be military buttons bearing the insignia of the Royal Irish Fusileers and while no one in the vicinity knew anything about the history of the remains, researches among the archives proved that the bones must have been those of soldiers who garrisoned the island in the days of our Revolutionary War.

Again while searching through the refuse of the long-deserted kitchen of an abandoned fort in Bermuda I found gun-flints, bullets, buttons, snuff-boxes, pipes, and numerous other relics of troops who were quartered there in the early days of the islands and some of the articles even dated back to the seventeenth century. Another time a number of rusty cannon-balls were dug up among our flower beds when we lived in the West Indies and by referring to local histories we found they had been thrown from Admiral Rodney's ship when he attacked the French back in 1782. This gave the relics a new interest and in searching for others my son discovered an ancient mortar hidden and overgrown with brush on a little eminence behind the house. Doubtless the gunners had been killed at their post, for the ball was still within the mortar's muzzle, where it had rusted fast, and the charge which the ancient cannon contained had never been fired.

Once, too, I stopped at a country farmhouse and in the lumber room where it had been cast aside I found an antique blunderbuss which had been handed down in the family from generation to generation. That it had really been used in the earliest days

of New England was proven by the fact that the tip of a stone arrow head was actually embedded in the stock. The owner considered it as of no particular value and gladly exchanged it for a cheap shotgun. If you collect firearms alone you can often pick up splendid specimens in junk shops and at pawnbrokers'. A friend of mine, who collected pistols, secured a collection of over one hundred different specimens, some of them of very curious and interesting design and many of them very old, by making a visit to every pawnshop he could find.

As these old firearms have no value whatever as weapons the pawnbrokers are usually glad to dispose of them at very low prices. Auction sales of household effects are also good places to search for war and historical relics and the boy who collects man-made objects must hunt for his specimens in all such out-of-the-way places, just as the boy who collects plants, insects, or similar specimens hunts through the fields and woods. There are numerous dealers in ancient war relics but many of these are unreliable and most of the things they sell are nothing but fakes and if they have genuine relics they charge outrageously for them. Oftentimes you may obtain many interesting war and his-

torical relics by exchanging with other boys. Collectors often start a collection of one thing and then decide to abandon that line and start something else and in such cases they are glad to exchange what they have gathered together for articles to put in their new collection.

Although specimens of weapons and similar objects should be kept in good condition and as perfect as possible it is a great mistake to attempt to restore them. If badly rusted the rust may be cleaned off and the specimen oiled, but the metal should never be scoured and polished, the wood work should never be repainted or revarnished, and in every case the specimen should be left in as nearly its natural condition as possible. When you obtain an old firearm of any sort use just as much care in handling it *as if you knew it was loaded.* Guns and pistols have been known to go off and kill people after they had been laid away for scores of years. *Never* snap the hammer or pull the trigger until after you have made sure there is no charge in the weapon and *never* point a gun or pistol at any one, even if you *know* it is not loaded. Don't handle edged or pointed weapons carelessly, especially if they are old. They may be dull and rusty

but bear in mind that a wound made by a dull thing is far worse than that made by a sharp object and remember that rusty or dirty metal will often cause death by blood poisoning. Remember that a relic is of little value unless its history is pretty well known, or unless it is dated, or its origin and age are proven by its style, design, or form and that unless actually genuine a relic or antique has no value whatever. When you get hold of a relic study its history as carefully as you would the life and habits of an insect or any other animal and make it more valuable and interesting by learning all about it. Don't make the mistake of thinking because Washington or some other celebrity slept in a certain house that a chip of wood, or a bit of brick from that house has any historical value or is a "relic." You might as well gather a handful of dirt from the street over which the person once rode. A photograph of the house or building is far more interesting and valuable. Don't confuse real relics and specimens with worthless junk. A piece of the battleship *Maine* may be of interest as an historical relic, but a bottle of water from Havana harbor or a box of mud from the same place is not a relic merely because the

Maine was destroyed there. This is a mistake which is all too frequently made by many collectors. A relic of any sort, to be worthy of the name, must be intimately associated or identified with the person or event which it represents. Thus the chip from the house which sheltered Washington would not be a relic and yet a button from our first President's clothing, his sword, hat, or even a letter written by him would be. And speaking of buttons, these make very interesting collections, especially if gathered and arranged for some particular purpose. A collection of military or naval buttons of the world, of buttons of historical interest, or even a collection of buttons made by different races or countries may be made very educational.

Even shoes make an interesting collection if properly carried out. I don't mean by this that a collection of ordinary boots, shoes, and slippers is of any value—except to wear—but a collection showing the footwear of various countries and of various times is both interesting and instructive. In such a collection there should be the sandal of the Oriental and of the Central American Indian, the wooden shoes of Europe, the straw slippers and paper-soled shoes of China and Japan, the odd

wooden clogs of Eastern races, the upturned-toed boots of the Balkan peoples, the odd boots of the Cossacks, the moccasins of the Indians, the fur boots of Eskimos, and, in fact, the foot coverings of as many races and periods as possible, with a few types of the latest patterns in boots, shoes, and slippers to show the contrast. I recently saw a very complete collection of this sort and I confess I was actually amazed at the interest it created and the educational value it possessed.

One boy whom I knew collected old door knockers. Some of these he obtained from deserted country houses, others he found in junk shops, others he purchased, and others he found in rubbish piles. By far the greater number were obtained by going through the country with a supply of cheap door bells and offering to install these free of charge in exchange for the old knockers on the farmhouse doors. His collection numbered several hundred specimens, many of them of intricate and beautiful pattern, and in the entire lot there were no two exactly alike. Still another boy friend collected snuff-boxes and between pawnshops, old houses, old people, antique shops, and "rummage sales" he managed to secure a collection which he

sold for a large sum to a professional collector of antiques.

In this collection were snuff-boxes of every imaginable shape, size, and kind; boxes of horn, tortoise shell, crystal, silver, lacquer, paper, wood, agate, and brass; some of them beautiful, others curious, and others of great historical interest and value.

Collections of door hinges, locks, clocks, latches, hats, canes, knives, cutlery, and in fact any utensil, weapon, instrument, or device used or made by man may be considered worthy of the making. Even if you are interested in but one class or group of such objects keep any others which you may run across, for some time you may find another collector who will be glad to secure the things you don't want in exchange for the things in which you *are* interested. Whatever you collect, collect in earnest, and aim to have the very best collection possible. Study your specimens and learn all you can about their history, use, origin, and manufacture. Make your collections systematic, complete, and educational and if you do this it matters very little what you collect.

CHAPTER XII

STAMPS, COINS, POSTCARDS, ETC.

NEARLY every boy has collected stamps at one time or another. Some have accumulated large numbers of stamps, and then tiring of them, have thrown them aside, while others have continued until now they own large and really valuable collections, for stamp collections—even if made by boys—are frequently worth many hundred dollars. At one time stamp collecting was considered a youthful fad and was hardly taken seriously; but nowadays there are enormous collections worth veritable fortunes and even single stamps are sometimes valued at several thousand dollars each.

Of course the boy collector cannot expect to secure specimens of these very rare and valuable stamps, for many of them are represented by a single specimen, or a very few specimens, and no others are in existence. But there are a great many very rare stamps which boys are liable to find

and even a collection of the commoner stamps, if well and carefully made, may be very interesting, educational, and valuable. Single specimens of rare stamps are not of as much importance in the ordinary collection as perfect sets and series of commoner varieties and specimens of the stamps of many countries. Very rare stamps, stamps in sheets, series of plate numbers, and similar specialties are better suited to advanced collectors with plenty of money to spend than to boys or beginners and from an educational point of view they are of comparatively little value. Many collectors confine themselves to one special country, or to a few countries, and while this is all very well for advanced collectors your aim should be to secure the stamps of as many different countries as possible. Of course any one can go to a stamp dealer and buy stamps, but this is not true collecting and the purchase of stamps should be confined to specimens which you require to fill gaps in sets or for duplicates to exchange with other collectors. When you first start collecting, however, it is a good plan to buy a number of cheap packets of assorted or mixed stamps, for among these you will be able to find enough to fill many spaces in your album and with

this start you will find a greater interest and incentive in filling out the gaps and building up the collection. The first thing to obtain is an album and any of the standard albums, such as Scott's will answer. Don't start in by sticking your stamps in a blank-book or old ledger. Sooner or later you will have to transfer them to a proper album and it never does a stamp any good to pull it from one place and fasten it in another and the less you handle and transfer your specimens the better. You should also secure a good stamp catalogue, for you will often require it to identify your specimens and it will also serve as a guide to the relative value and rarity of the various stamps. When you first begin collecting you will progress much more rapidly than after you have been collecting a few months. For a short time nearly every stamp you obtain will be new to your collection, but you must remember that each specimen you place in your album makes one less for you to obtain and therefore don't become discouraged when you find it is difficult to secure stamps which your album does not already contain. Don't throw away or refuse a stamp that is injured, torn or badly cancelled until you secure a better one. A very

poor stamp is better than none at all, even if it has no monetary value whatever. Keep your eyes open for better specimens to replace those that are poor and in time your collection will contain none but perfect specimens. Never cut a stamp from the envelope or paper upon which it is placed, but soak it off in water. A stamp is of little value if the perforations around the edges have been cut or torn away and many varieties of stamps are classified by the number of these notches. Don't consider a stamp as a duplicate until you are absolutely sure that it is not different in some minor detail from the specimens it resembles. Many stamps appear identical at first glance and yet one may be very common and the other extremely rare. Aside from the number of perforations there are watermarks, dies, shades, papers, and many other variations in stamps which bear the same color, value, and design. These minor differences are likely to be overlooked by beginners and boys, but to the advanced collector and expert they are of the utmost importance.

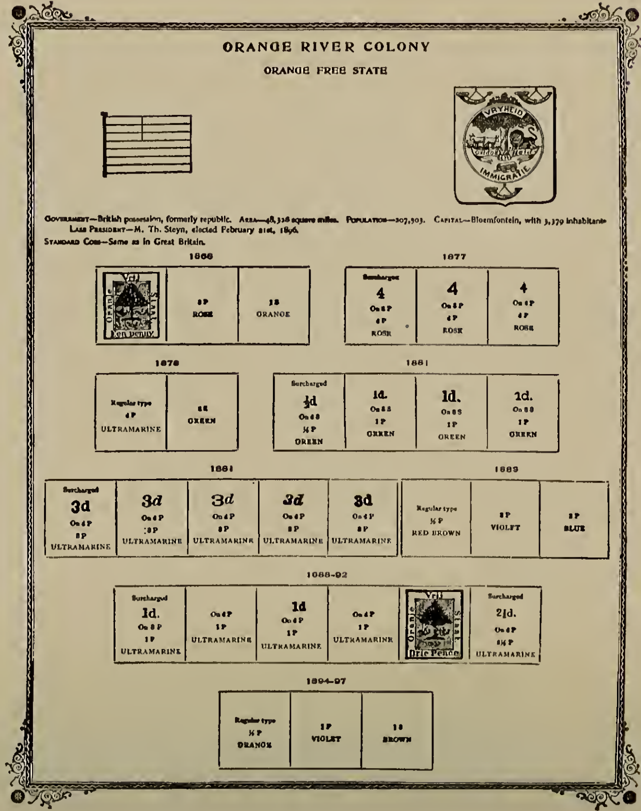
The stamps issued by a certain country one year may be of the same color, design, and values as those of another year and yet one issue may be very common indeed and the other issue may be exces-

Stamp Showing Rulers

Stamps Showing Birds and Animals

(See Chapter XII)

Stamps to Show Scenes of Various Countries



Page from a Stamp Album

(See Chapter XII)

sively rare and valuable. The only way in which many of these issues can be distinguished is by means of the paper on which they are printed, the number of perforations on the edges, the shades of the colors, little details of the dies or plates with which they are printed or the watermarks of the paper from which the stamps are made. Every stamp album and catalogue lists these little differences and the boy collector will find it very interesting and pleasurable work to search for the hidden marks and characteristics which determine the issues of his specimens. Water marks may be discovered by soaking the stamps in gasolene and placing them, back-side-up, on a dark background. Perforations may be measured by gages, which are furnished by dealers in stamps; shades may be identified by comparison with color-charts and the various dies and papers are described in the catalogues. Stamps with and without perforations should be considered as distinct varieties; but of course this doesn't mean that a stamp from which the perforations have been cut is different from one in which they remain intact; it only applies to stamps which are made with or without the perforations. Thus, the ordinary

two cent United States stamps are perforated, but many of those made for vending machines are not perforated. Sometimes tiny pin-holes, little longitudinal cuts, or similar methods of separating the stamps are used instead of perforations and each of these makes the stamp which bears it a distinct variety from similar stamps made in a different manner.

Many collectors strive to obtain unused stamps and while these are very much prettier and look better than used stamps, yet cancelled specimens are often better for collections than those which have never been used. There are thousands of counterfeit stamps, reprints, and forgeries in existence and the amateur is very likely to have these foisted upon him when he collects unused stamps. Cancelled stamps are far more likely to be genuine and many of the rarer issues are far more valuable in a used than in an unused state. The lighter a stamp is cancelled the better and whenever you secure a lightly cancelled duplicate, substitute it for the more heavily cancelled specimen in your album. Be careful not to confuse surcharges and precancellations with the ordinary cancellations on stamps. Surcharges are printed across stamps by the post-

office authorities and in many instances surcharged stamps are far rarer and more valuable than those of the same issue without the printed numbers or words across them.

Sometimes a post-office is short of a certain stamp and those of another issue are used with a different valuation printed in ink across their faces. At other times one country uses the stamps of another with a surcharge printed across them, while still other countries use their home stamps for their colonies and surcharge the name of the colony across the stamps. At the present time many of the European countries are using surcharged stamps and these are in great demand, for when the great war is over these stamps will no longer be used and will become very rare. Precancelled stamps bear the name of the post-office printed across them and you can find United States stamps precancelled with "New York," "Boston," "St. Louis," and many other towns and cities. These should all be saved and properly arranged in the album. Sometimes too you may find freak stamps or errors. These may be stamps in which the wrong colors are used, stamps in which the center is upside down or inverted, and stamps which are printed in the color of one issue

and the value of another. All these should be collected and saved for they are always rare. A few may now and then slip past the inspection by the officials and get into circulation, but as soon as they are detected no more will be issued and those on hand will be withdrawn and hence the few that have gone forth will be all that can ever be secured. At times stamps are halved or quartered by the post-office officials instead of being surcharged. Such stamps, if unused, have no particular value, but if cancelled, and more especially if upon the original envelopes, they are very interesting and are sometimes very rare. If you ever happen to be at any place where cut stamps are being used don't fail to secure all you can on the original envelopes. Once, when I was in the Danish West Indies, I found one of the post-offices using diagonally cut stamps and I immediately purchased all I could obtain, stuck them on envelopes addressed to myself, mailed them, and secured a fine collection of the cancelled, cut stamps on the envelopes before my steamer sailed.

If you obtain a rare or unusual stamp upon the original envelope always preserve the envelope and stamp entire; such specimens always have a greater

interest and value than the stamp by itself; but this does not apply to the common every-day varieties. Many collectors pay no attention to envelope stamps, newspaper wrappers, or postcard stamps, but for the boy collector these are just as desirable as any other stamps and should be preserved. Envelope stamps may be kept with the envelopes entire, but unless they are scarce or rare issues this is hardly worth while, as they occupy a great deal of space. For ordinary purposes the envelope should be cut with a good-sized square of paper surrounding the stamp; never trim it oval or round close to the stamp's outline.

Whenever you find two or more stamps which have not been torn apart at the perforations preserve them without separating them. Many collectors prize these "pairs" or parts of sheets far more than stamps which have been detached and even if you prefer single stamps for your own collection you can often trade the pairs to advantage.

Some collectors even go so far as to collect entire sheets of stamps as they come from the press and others are enthusiastic over plate-numbers, or corner stamps, on which two edges of the sheet shows. These fads are all very well for those who

have so many stamps in their albums that sheets and similar specialties offer the only field for adding to their collections, but for practical purposes or for boys' collections they are of no particular interest or value. If, however, you secure a sheet of rare or unusual stamps, by all means keep it intact—it may be worth many times the aggregate value of the separate stamps it comprises. It is the same way with stamps bearing plate-numbers; keep these whenever you can for trading purposes, unless you want to commence the endless work of collecting series of plate-numbers yourself. If you have two or more stamps of the same sort, retain the most perfect one for your album; examine them for perfect perforations, light cancellation, freedom from tears, breaks, or imperfections and also give attention to the centering of the design. Stamps in two or more colors have the central pattern or "medallion" printed separately from the rest of the design and quite frequently these do not fit accurately into the spaces made for them. Sometimes the medallion may be far to one side or too far up or down on the stamp and such specimens are often rare and worth keeping; but if the design is only slightly out of position it detracts from the value and perfec-

tion of the stamp and the specimen with the most perfectly centered design should be retained.

Never paste, glue, or stick stamps into an album or onto a sheet of paper, but mount them on regular stamp-hinges which may be purchased very cheaply from dealers. Many a rare stamp has been ruined by pasting it in an album.

You may often hear of stamps with "original gum" and in many cases these are listed at far higher prices than those which have been soaked off in water. These are no better for your collection than those which have been used and have no original gum left on, but as other collectors may prefer them you will do well to keep any stamps with the original gum for exchanging.

Never throw away, give away, or exchange *all* of your duplicates of any stamp; you never can tell how soon a common stamp may become very rare. The stamps of Belgium, which were once so common that many collectors avoided them, are now in great demand owing to the war in Europe and many of the issues, which were formerly worth nothing, may be worth a great deal of money before the war is over. Many a collector has spent hours of vain regret thinking how, in the past, he has dis-

carded or given away stamps which are now prized rarities. It's far wiser to keep a good number of duplicates of common stamps for future developments than to find yourself short when the stamps *do* become scarce.

In classifying and arranging your collection you will have to depend very largely upon the catalogues and albums, but before you do this you must obtain the stamps themselves. When you first start collecting you will find it a good plan to purchase a few packages of mixed stamps as I have already mentioned. Then ask your parents, relatives, and friends to save any stamps they can find on old letters, as well as any they receive. Sometimes you'll find a veritable treasure-trove among the old letters stored away in your own home, but as a rule you'll have to go farther afield for your specimens. If your father has friends who are importers or have correspondents in other countries wheedle him into asking them for stamps. The old saying that "All's fair in love or war" might be applied very aptly to stamp-collecting, for if you expect to secure stamps you must be prepared to leave no stone unturned to obtain them. I don't mean by this that you must make a nuisance of yourself, but

don't be afraid to ask any one and every one for stamps. If they collect themselves they'll no doubt be willing to give you all the duplicates they receive or they'll exchange specimens with you; and if they don't collect they'll probably be gracious enough to save any stamps they receive. At any rate it will do no harm to ask and you may be well rewarded. Visit the offices of the various steamship lines—usually you can coax some office boy or clerk into gathering stamps for you and many of these will be of high values which you would never obtain from ordinary letters. If you can get acquainted with the employees of the foreign consulates you will also be able to secure many good specimens. Sailors, officers, and captains of steamers and sailing vessels often have quantities of foreign stamps and if you want unused sets, the ships' officers will usually be willing to purchase them for you at the various ports they visit. Now and then you may obtain a regular windfall from some unexpected source and the stamp collector must ever keep on the alert and must develop the true collector's instinct for finding specimens if he expects to be successful. Old stores, old factories, old offices, and old houses often contain files and pack-

ages of old letters, bills, receipts, etc., with the stamps still intact and if you can secure permission to look through these you will find many rare specimens. Although dealers and collectors have gone over nearly every country, searching here, there, and everywhere for stamps, yet there are plenty of rarities still unfound and hidden away and you've just as good a chance to find these as has any one else. If you spend your summers in the country visit all the old farmhouses and country stores and poke about in all the old closets, garrets, and lumber-rooms. In some old hair-covered trunk, some moth-eaten carpet-bag, or some forgotten book you may find untold riches in stamps. The annals of stamp collecting are filled with stories of such finds and in many instances the lucky finder has reaped a small fortune from his discovery. When I was a boy a friend and myself, while poking about in an old, discarded desk, discovered a bundle containing dozens of unused newspaper wrappers and many sheets of unused stamps of the issues of the early sixties. They had slipped down behind the drawer and had lodged on a narrow ledge of wood where they had remained undetected for years. If you run across old furniture don't fail to pull out

the drawers, open the doors, examine the upholstery, and search every nook and crevice for mislaid stamps. If you have any old books within reach look them over carefully. Our ancestors had a habit of slipping stamps, as well as letters, between the pages of their books and I've found many rare specimens in such places. One of my friends, who collected insects, once received a very large collection of butterflies and moths from South Africa. I happened to visit him as he was examining his specimens and noticed that the insects were all preserved in corners cut from envelopes. An investigation followed and I went home with a pocketful of old Natal and Cape of Good Hope issues with several of the prized triangular stamps among them.

At another time, while traveling in the West Indies, the steamer called unexpectedly at a little out-of-the-way port where the regular ships never stopped. It was late in the evening when we arrived and we were told the vessel would sail within two hours. As soon as I landed at the little dock I asked the negro boys who surrounded us to run about the tiny port and bring me all the old stamps they could find and promised to pay them for all

they secured. The prospect of a few pennies or shillings sent them scampering in every direction and each tried to outdo his fellows. In half an hour they began to return and before the roar of the ship's whistle warned us that we must leave my pockets were bulging with letters, papers, old bills and loose stamps. I had no time to look them over, or even to glance at them, and hurriedly paying the boys I boarded the steamer. Of course a great many of the stamps I found in this accumulation were common, injured, or of no value, but among the lot were numbers of the old Virgin Island stamps, some very rare surcharges, several errors, some cut stamps on the original envelopes and a good assortment of revenue stamps used for postage. I was not collecting for myself, but for a dealer, and the expenditure of a few shillings and an hour's time netted me something over one hundred dollars. I mention this as an example of how well it pays stamp collectors to be ready to take advantage of every opportunity which presents itself.

The strangest experience I ever had with stamps was in Colon, a few years after the great fire. I was dining at a tiny restaurant and casually enquired of the Spanish proprietor if he had any old

stamps. He led the way to a rear room, dragged a big iron-bound chest from beneath a bed and threw back the lid. Imagine my surprise at finding the big chest filled to overflowing with thousands of stamps from every quarter of the globe! The bulk of them were from the South American countries and the stamps of Colombia were more numerous than any others. It would have taken months to have assorted that collection, but even at a glance numerous rarities were evident. I tried to buy the entire chest, but the old fellow refused to sell. I wanted to pick out some specimens and buy them and he wouldn't consent to it. Then he offered to make me a present of a handful that he scooped up and I was compelled to be satisfied with that. He had been saving stamps in this odd fashion for years and time and again I've wondered what finally became of the vast hoard he had accumulated.

Aside from their interest as specimens, stamps possess a great educational value and by studying your collection you can learn a great deal which you would never learn in any other way. You will become familiar with the coats of arms, flags, and emblems of the various countries. You will soon

remember the names of their rulers and whether they are monarchies, republics, or dependencies of other nations, and you'll have to learn their monetary systems, standards of currency, and their equivalents in our own money. You'll find that some countries are independent, some are colonies, some are protectorates, and that some are occupied and controlled by two or more nations, and you'll discover a great deal about the histories of many lands.

Some stamps bear portraits of rulers, patriots, and prominent men and these are usually excellent likenesses and will give you a very good idea of the appearance of the great men of other lands. Other stamps have designs showing the native birds, beasts, and plants and from these you can find out much about the strange fauna and flora of foreign countries. Still other stamps show the industries and commerce of the people and others bear pictures of notable buildings and monuments or bits of scenery, such as great waterfalls, mountains, volcanoes, or prehistoric ruins. All of these are instructive and if you desire you may make separate collections of stamps arranged so as to illustrate all these things. From a collection of stamps you may

easily obtain series showing the greatest and most important buildings in the world, the most notable men, the rulers of many lands, their commerce, industries and manufactures, their products and resources, the costumes and habits of the people, and a fairly complete menagerie of the birds and animals of the globe.

Coins

Somehow stamps and coins always seem to go together. Stamp dealers are usually coin dealers and a great many stamp collectors also collect coins and vice versa. Personally I never could see any good reason for collecting coins—except in banks—but there is no reason why any boy should not collect coins if he wants to. If you *do* collect coins don't get too deeply interested or strive to make your collection *too* complete. Coins have a definite value as currency, aside from their value as specimens, and unlike stamps and other things current coins are worth their face value.

For these reasons you cannot obtain modern coins, which are in circulation, without paying for them and to secure a good collection of current coins means a large outlay of money. It's a dif-

ferent matter with old coins, however, and I advise any boy who wishes to collect coins to confine himself to old coins, or to those of small denominations. A collection of copper cents and half-cents of the United States is interesting and a large series of specimens may easily be obtained. Many foreign countries have issued vast numbers of coins of low values which may be collected and really old coins of any country are always suitable for collections. Coins require less care than stamps, for they are not easily injured; but the same care should be used in obtaining perfect specimens, in discriminating between the minor varieties, and in making your series as complete as possible. You can scarcely expect your friends to save up coins for you, but if they know you are collecting they'll frequently put aside odd or old coins that they receive. As in the case of many other objects you will often find good specimens of coins in junk shops, at pawnbrokers', and in antique stores. Many of these will be common and of little value but now and then a corroded, illegible coin will turn out to be a real rarity. In old houses, in garrets, in antique furniture and old wallets you will sometimes find rare coins and once in a while an ancient coin, or a number of

coins will be dug up from its hiding place or disclosed when an old building is demolished. Coin collectors are not as numerous as stamp collectors and the world has not been searched as carefully for coins as for stamps and in many out-of-the-way places you may still obtain quantities of interesting old coins in splendid condition. Don't make the mistake of thinking that age alone gives a coin its value. There are plenty of old Roman, Greek, and other ancient coins which are worth but a few cents each, while certain coins of the United States are valued by hundreds or thousands of dollars. The rarity of a coin depends upon the number of its kind, not upon its age, but many old coins are of course very valuable. Even if a coin is not of great value its age may make it interesting and associations—historical and otherwise—may make it still more desirable. In Latin America and the Orient there are thousands of coins in daily use which were coined in the days of the buccaneers and pirates. Some of these are great golden Spanish "Onzas," others are doubloons, and others are the silver "pieces of eight" which are always associated with the freebooters of the Spanish Main. These all pass at their face value and are not con-

sidered rarities, but their associations make them extremely interesting to the boy collector. No doubt many of these old Spanish coins once jingled in the pockets of Morgan, Lafitte, Drake, and other piratical characters. Many of them helped to pay the ransoms of towns and cities. Imagine the thrilling tales that these old pieces of silver and gold could relate, if they could only speak; the battles they have witnessed, the cruelties and butcheries which have been perpetrated to win them; the bloodshed which they have caused, and the hilarious times and unspeakable orgies which they have been the means of furnishing since the days when they first were struck in the mints of Spain. But if you collect coins, strive to make your collection educational as well as interesting. Do not confine yourself to the minted metal coins of civilized lands, but also collect the currency of strange and savage races. The cowry shells of the East Indies are just as much "coins" to the natives as our dollars and cents are to us. The Indians used "wampum," tusk-shells, and beads. Many of the South and Central American tribes still barter with bottles, buttons, and teeth for currency and in many other corners of the globe similar strange

forms of money may be founded. All these add to the interest and value of the coin collection and should be included in it.

Picture Post-cards

I have already mentioned post-cards when speaking of the stamp collection, but these should not be confused with the popular picture post-cards which are issued without stamps by private firms or individuals. Many people "collect" picture post-cards, just as they "collect" Christmas and New Year's cards, valentines, and photographs of their friends and acquaintances. Such so-called collections have little interest and no real value, for they include impossible views, comic pictures, foolish mottos, and all sorts of trash. For this reason picture post-cards have fallen into disrepute, but as a matter of fact certain picture post-cards are well worth collecting and are both instructive and interesting. Many picture post-cards bear beautiful photographs of scenery; others show monuments, buildings, and similar objects, while still others picture the native people at their occupations, industries, and in their home life. A collection of such cards can be made very interesting and

the collector can learn a vast amount about the various countries and places from which the cards come. Whenever you visit any city or country secure a series of the cards with good pictures of typical scenery, prominent monuments or buildings, or of the people at work and play. Whenever a relative or friend goes abroad or travels anywhere ask him, or her, to send cards from the various places visited, and make it plain that the cards you want are those with good pictures of the scenery, buildings, and people. Exchange cards whenever you can and by these means you will be able to form a collection which will surprise both yourself and your friends and will be far more interesting than many collections of more valuable specimens. The real object of every collection should be to teach something; the ultimate aim of every collector should be to acquire knowledge. If this is accomplished it doesn't matter what you collect, and while there may be "sermons in stones" there is also a liberal education in a good collection of picture post-cards.

THE END

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